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ABSTRACT

Two conferences were organized by the Education Committee of the Southeastern Pennsylvania Section of the American Chemical Society (SEPACS) with the assistance of Shippensburg University (SU) to examine the nature and depth of the growing trend of scientific and technological illiteracy in southeastern Pennsylvania and to propose and effect solutions to the problem. These proceedings of both conferences include eight papers and a summary of a panel discussion. The papers are: (1) "Science in Decline" (John H. Grezlak); (2) "Time for a New Attitude" (Joseph Sollenberger); (3) "Science Education and the American Chemical Society" (Keith Peterman); (4) "Excellence in Science Education" (Anthony Ceddia); (5) "American Resourcefulness and the Science Education Crisis" (Paul E. Bell); (6) "Problems in Science Education" (Margaret Smith); (7) "Science Education" (Jeff Coy); and (8) "Science Education: Is It Ill?" (Larry Wm. Graham). A summary highlighting the major areas addressed in each of the papers is included in the preface. Appendices include: a list of proposed solutions to problems in science education; a brief report on results from an American Chemical Society study on chemical education in the United States (considering chemical education for the general public, for other sciences and technologies, and for a career in chemistry); a list of needs and requirements for better education in science and technology; and results of two surveys. (JN)

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Proceedings of Conferences in Science Education

Sept. 24, 1983
Nov. 19, 1983

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PROCEEDINGS

OF THE

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IN

SCIENCE EDUCATION

Preface

In April, 1983 the National Commission on Excellence in Education issued the report A Nation at Risk, citing a general decline in education in the United States. A large and significant part of this report documented a growing trend of scientific and technological illiteracy and discussed the causes of and solutions to the specific problems contributing to this trend.

The impact of such a trend is obvious. We are in danger of losing our leadership role in science and technology. Built upon this role, our economy as well as the economic well-being of our citizens are being threatened. Concerned with this trend and its possible consequences and with the assistance of Shippensburg University, the Education Committee of the Southeastern Pennsylvania Section of the American Chemical Society (SEPACS) organized two conferences in science education. The goals of these conferences were to ascertain the exact nature and depth of these problems in southeastern Pennsylvania and to propose and effect solutions.

Often the examination of problems in science education relies heavily upon the input of individuals and groups only remotely involved with these problems. Too often the input of science teachers i.e. the front-line troups is largely ignored. However, it is the science teacher who faces these problems first-hand on a daily basis. It is the science teacher who often knows first-hand what must be done and who most often will have to do it.

Conference I, which was held on September 24, 1983, was designed to obtain and benefit by the input of this group and called together the chemistry teachers in southeastern Pennsylvania. In the opening remarks of this conference, Dr. John H. Grezlak presented the participants with a summary of the problems facing science education in the United States and in the Commonwealth of Pennsylvania and tabulated the proposed causes and solutions (Science in Decline and Appendix I). The participants were then charged to determine the nature and depth of these problems in southeastern Pennsylvania and to propose valid and reasonable solutions.

In his paper Time for a New Attitude, Mr. Joseph Sollenberger summarizes the results of these deliberations. Discussions had centered on (1) salaries, (2) the lack of professional attitudes toward education, (3) the lack of financial support, (4) aggravations in teaching, (5) the lack of meaningful in-service programs and (6) the lack of standards. Mr. Sollenberger points out that southeastern Pennsylvania is not immuned to the problems which face science education in the U.S. He concludes that many of these are beyond the reach of science educators and school districts and can only be solved by a joint effort of academe, government, industry and the community.

Mr. Sollenberger's paper formed the basis of Conference II. Leaders in education, government, industry and the American Chemical Society were called upon to examine these results and to join in a dialog with local science educators and school officials. Each was asked to present a paper describing these

problems as they relate to his/her own expertise and profession and to detail what he/she and his/her profession has done and will do to solve these problems. The emphasis of Conference II was action and commitment.

In his paper Science Education and the American Chemical Society, Dr. Keith Peterman (Professor of Chemistry, York College of Pennsylvania and Chairperson, SEPACS) emphasizes the importance of science education in the elementary school and describes an enrichment program for elementary school students which he conducts on a yearly basis. Dr. Peterman also describes the multitude of services that the ACS and SEPACS provide to high school educators: awards in teaching, short courses and continuing education programs and publications in chemistry, professional standards, teacher preparation and standards, etc. Dr. Peterman further proposes new initiatives by SEPACS to assist high school educators and describes the results of the latest ACS study on chemical education in the United States (Appendix II).

In Excellence in Science Education, Dr. Anthony Ceddia (President, Shippensburg University) cautions against too much emphasis on quantity, on statistics, on regulations and emphasizes quality in science education. He describes the mistakes that higher education had made in this area in the past and the new initiatives being taken by higher education in general and by Shippensburg University in particular to improve the quality of science education in the Commonwealth. These include an orientation and education program for new school board members, community awareness programs, University - high school partnerships and efforts in restructuring preservice programs in elementary and secondary education to place a greater emphasis on science. Dr. Ceddia also discusses the limitations faced by both higher and basic education because of manpower and financial constraints and urges increased support by the community, by local and state government and, in particular, by the federal government through its NSF programs which had been so successful in the past.

In American Resourcefulness and the Science Education Crisis, Dr. Paul E. Bell (Professor of Education, Pennsylvania State University) provides a wealth of alternative approaches for solving the problems in math and science education based upon the resourcefulness of our society. He discusses ways of teaching and motivating students to learn science for themselves by incorporating, for example, math and science concepts into other disciplines. He explores in detail the proper role of the microcomputer in education and the way that the computer and other technology may not only improve education but also solve the teacher shortage, both at minimal cost.

Representing the Pennsylvania Department of Education, Dr. Margaret Smith (Commissioner of Basic Education) discusses the lack of science in the elementary and secondary school curricula, the impending shortage of math and science teachers in Pennsylvania and the lack of women and minority representation in the sciences. Dr. Smith describes the current investigations by government task forces in the areas of curriculum, staffing and partnerships with industry as well as the Governor's proposed agenda for excellence.

From the state legislature were Mr. David Myers (Executive Director, Minority Staff, Pennsylvania Senate Education Committee) who represented Senator Jeanette Reibman, Minority Chairperson, Senate Education Committee and Representative Jeff Coy (Education Committee, Pennsylvania House of Representatives) who also represented Representative James Gallagher, Chairperson, Education Committee, Pennsylvania House of Representatives. In their presentations, Mr. Myers (Presentation incorporated in the Panel Discussion) and Representative Coy (Science Education) present the current and future legislation being prepared by the House and the Senate to improve science education in Pennsylvania. Representative Coy discusses, for example, House Bill 1181 which mandates new curriculum requirements with a greater emphasis on science as well as student competency testing. Mr. Myers details the PHEAA programs in this area and discusses new legislation which would mandate minimum starting teacher salaries and which would award corporate tax credits for the donation of computer and scientific equipment to education.

Representing industry, Mr. Larry Graham (Process Engineer, Appleton Papers, Inc.) and Dr. Howard Peiffer (AMP, Inc.) discuss the impact of the problems in science education on the industrial community. Both participants, however, provide additional insights. Mr. Graham, for example, is also Secretary of SEPACS and a former teacher. In his paper Science Education: Is it Ill?, he places the problems in science education in their proper perspective by citing cases of excellence in education. Whereas he places the responsibility for the financial support of education on local, state and federal governments, he places the responsibility for education itself squarely on the education profession and suggests the necessary actions which must be taken to cure its ills.

A former school board member, Dr. Peiffer applies this knowledge and his business expertise in outlining the needs and requirements for better education in science and technology (Appendix III). Dr. Peiffer, for example, stresses the need to develop teacher evaluation programs similar to those employed by industry. Such a program is further discussed in the Panel Discussion.

The question and answer periods which followed these presentations and the subsequent panel discussion provided a dialog between teachers, school administrators and the speakers. In the section Panel Discussion, the editor uses a narrative approach to summarize this dialog. Discussion centers on (1) the status of education, (2) student attitudes, (3) quality control, (4) attracting quality students to teaching, (5) maintaining and improving quality in teachers, (6) keeping quality teachers and (7) the future of education.

Completing these proceedings are the results of two area surveys on education. Although limited by the degree of participation, both surveys provide additional interesting information concerning the problems in southeastern Pennsylvania. College freshman chemistry majors, for example, choose science over education because of the following factors in order of decreasing importance: (1) work duties and responsibilities, (2) low salaries and lack of financial support and (3) lack of

prestige and respect (Appendix IV). In a survey of the participants attending Conference II, the major problems confronting science education in southeastern Pennsylvania are (1) low prestige and lack of respect for the teaching profession, (2) low teacher salaries and lack of financial support and (3) lack of meaningful professional development activities (Appendix V). Considering the parallel, it is somewhat interesting to note little movement in these areas.

These proceedings provide an abundance of material concerning the problems in science education in the U.S. and in southeastern Pennsylvania, the causes of these problems and their solutions. In the past few months they have led to increased high school - university interactions, the establishment of a chemistry olympics sponsored by the ACS and a conference on chemical demonstrations. As the conferees were asked, we ask you the reader to consider this material carefully, select a course of action that can contribute to better education and act. We and society have all benefited from the education that we had received in the past. We have an obligation to ensure that our children and future societies receive the same if not better benefits.

The editor wishes to express his appreciation to the excellent speakers and the quality educators who participated in these conferences and to SEPACS, Shippensburg University and the ACS Committee on Local Section Activities for the funding of these conferences and the publication of these proceedings.

John H. Grezlak, Editor

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Science in Decline

John H. Grezlak
Associate Professor of Chemistry, S.U.
Chairperson, Education Committee, SEPACS

Today we are told that the Nation is at risk. Yet yesterday it was resting comfortably on the benefits derived from science and technology. Its stomach was full from an abundance of food arising through the use of synthetic pesticides, herbicides, fertilizers, pheromones and genetic hybridization; through shapes of processed metals and synthetic polymers which, when powered by cracked hydrocarbons, tilled the fields and harvested the crops; and through the additives and polymeric films which have prevented oxidation and bacterial action from destroying 50% of what was harvested as well as the harvestor and his beneficiaries.

Yesterday it felt healthy knowing that groups of atoms unknown to Nature or jealously guarded by her have been wrested from her arms or constructed in testtubes made of sand in order to cure its diseases and disorders and to extend its lifetime. Yesterday it felt secure knowing that the decaying atoms of Einstein, Curie and Oppenheimer would prevent the raping of its boundaries. Yesterday its soul was soothed by the music of wood and metal, whole orchestras contained in a magnetic box or in the grooves of plastic. Yesterday fears of a thousand years, of capricious gods and unruly forces were disspelled as Nature unfolded her knowledge, knowledge which spread to all on wood, on subatomic particles, on flashes of light through fibrous glass and chips of silicon hundreds of miles in the sky.

Today we are told that the Nation is at risk. Yet yesterday our hopes were strong. We saw a vision of boundless, clean energy - from the sun and its man-made child, fusion. We saw visions of genetic engineering creating crops that fed themselves, cancer drugs and chemicals to cure the troubled mind. Dreams of plastic hearts and organs were within our grasp.

Still, today we are told that the Nation is at risk. "Our once unchallenged preeminence in commerce, industry, science and technological innovation is being overtaken by competitors throughout the world."[1] We are no longer the world's largest supplier of steel. Our automobiles are no longer desired by the world and face stiff competition within our own boundaries in spite of import quotas. We are no longer self-sufficient in energy, depending heavily on middle eastern and southern countries. With technological achievements like the video camera and recorder as well as the state-of-the art technology in photovoltaics bearing Japanese names, our lead in electronics has been reduced. Particle beam instruments of defense and destruction lie in Soviet hands. Leaders in plastics processing are now English, German and Japanese, and polymer synthesis, once the exclusive realm of American scientists, is facing a European and Asian onslaught. We bear witness to a decreasing quantity and proportion of patents bearing U.S. names.

As if grasping for straws, we have convinced ourselves that we are now in an informational revolution that will maintain our lifestyle. We have forgotten that this itself is only one more manifestation of science and technology. We have forgotten that data processing and manipulation requires the input of data, much of which is scientific and gathered painstakenly in the laboratory. We have forgotten that chemistry, physics, biology and engineering are experimental sciences. We must be reminded that the input for the Merck computer which designs new drugs and miracle cures must be obtained through laboratory synthesis and property investigations, that the software utilized is written by people well versed in mathematics and that the computer designed drug must still be synthesized and tested in the laboratory. We have forgotten that our role in the informational revolution will also depend upon our role in computer technology, on new and better polymeric photoresists etched by photoelectron beams. Even now the fact that Japan possesses the latest technology in microcomputer chip production (CMOS) is largely ignored by our citizenry.

Over the years our Nation has grown accustomed to the benefits and comforts of science and her parent, science education. Fueled by a growing scientific illiteracy, it has come to believe that somehow, with little or no support, American science will continue to supply its benefits and promote a healthy economy and that again, with little or no support, our educational system will continue to provide the tools, the training, the knowledge and the people necessary not only to carry out this charge but also to support this charge. We scientists and educators have known for years that this need not be the case. Only now through the efforts of a few educators and responsible journalists has the Nation been shocked into this realization.

The economic well being of our technological society is being threatened not only because the production of highly trained scientists and educators is dwindling but also because the increasing nonscientific portion of our society who must support science is becoming less knowledgeable in this area. With the support of a nation, nonscientists have reduced funding for basic research and eliminated programs in space exploration. Yet it was the basic research of Scott, Faraday and Helmholtz that gave us the telephone. Investigations into Einstein's theories gave us nuclear energy and laser technology. The cathode ray tube of Crookes is now our television and our lightbulb. Our microcomputer, our knowledge of weather, our weather and communications satellites are all children of space.

The future of nuclear energy is in question today not so much because of a knowledge of its controllable chemistry and its effects but more because of a lack of this knowledge and the fears that this lack generates. Yet, if nuclear energy is not the answer to dwindling energy

supplies, what is the answer? Is it the synfuels and the research in this area which our government and business leaders have curtailed because the painstakenly slow and expensive process of scientific investigation into an unknown world of no guarantees does not conform to short term MBO objectives? Or is it our current commercial use of fusion. (Many scientists will argue that the use of fusion lies 30 years in the future. I argue that it must exist today because scientists thirty years ago predicted it would.)

Today, even the enormous promises of genetic engineering are being threatened not only by ill-informed investors who have been disappointed that MBO short term objectives have not immediately yielded miraculous scientific achievements and financial profits but also by fears that man will create in a few experiments a monster that Nature has failed to create during four million years and billions of genetic experiments. Science illiteracy is recreating the mysterious and malevolent gods of old and, in doing so, is threatening the benefits of knowledge.

Science illiteracy has been identified as part of an overall trend of increasing mediocrity in our educational system. The indicators are clear and obvious:[1]

1. International comparisons of student achievement completed a decade ago reveal that on 19 academic tests American students were never first or second and, in comparison with other industrialized nations, were last seven times.
2. Average achievement of high school students on most standardized tests is now lower than 26 years ago.
3. College Board achievement scores reveal consistent declines in recent years in subjects such as physics and English.
4. Both the number and proportion of students demonstrating superior achievement on the SAT's have dramatically declined.
5. There was a steady decline in science achievement scores of United States 17-year-olds as measured by national assessments of science in 1969, 1973 and 1977.
6. Average tested achievement of students graduating from college is also lower.

A major contributing factor to these trends is curricula weak in mathematics and science. 35 states require only one year of high school mathematics; 36 require only 1 year of science.[1] Even if we ignore computer science and language, only 13% of the 1983 high school graduating class met the academic requirements recommended by the NCEE.[2]

In order to eliminate this deficiency in curricula, the NCEE has recommended that all students be required to take:[1]

1. 4 years of English
2. 3 years of mathematics
3. 3 years of science (physical and biological)
4. 3 years of social studies
5. ½ year of computer science
6. 2 years of a foreign language for the college-bound

Similar recommendations have been made by the National Science Foundation[3] and the Carnegie Foundation for the Advancement of Teaching.[4]

Pennsylvania is currently one state that does not conform to these recommendations. However, legislative action is currently underway. House Bill 1181, which will make these recommendations (except for the foreign language) required,[5] has been recently approved by the PA House Education Committee and submitted to the full House. House action is expected next month. Similar and independent proposals are under consideration by the Pennsylvania Department of Education.[5,6]

Higher education, of course, is not immuned to the actions of secondary education nor to the problems associated with education. With the weakening of secondary school graduation requirements came a concurrent weakening of college entrance requirements. Being separate governing entities, colleges and universities have varied with respect to this weakening. Franklin and Marshall College, for example, requires only that the student has graduated from a precollege program from a reputable high school. They strongly recommend, however, that this preparation includes the courses described by the NCEE plus a third year of a foreign language.[7] Strong competition in enrollment all but guarantees adherence to these guidelines. Within the SSHE system, the entrance requirements are not as rigorous. All that is generally required is graduation from a reputable school. Students who have pursued the general track in high school are routinely matriculated.

College graduation requirements also vary, not only between colleges but also between programs. In chemistry, adherence to high standards is guaranteed through ACS accreditation which mandates courses, time, library holdings, etc. Weak curricula, nevertheless, still exists. There are colleges and universities granting degrees in chemistry which either do not meet ACS guidelines or barely do. There are colleges in Pennsylvania who graduate chemistry teachers having a chemistry background equivalent to the Minor in Chemistry at S.U. and far less than S.U.'s B.S. Ed. Science oriented programs exist which do not require any math higher than algebra or chemistry and physics above the nonscience level. Even college general education requirements in the physical sciences are weak; it is entirely possible and reasonable for a student to graduate from a high school and a particular program in higher education without ever having taken a course in the physical sciences. If the deficiency of weak curricula is to be eliminated, colleges and universities will also have to play a role. APSCUF, the faculty union of SSHE, has established a committee to investigate such deficiencies.

A second factor contributing to science illiteracy is the increasing shortage of qualified math and science teachers. Beginning in the early 1970's, unfilled teaching positions in the physical sciences reached a nationwide level of 400 in 1977, second only to mathematics, bilingual education and special education.[8] At that time the shortage was predicted to increase to 700 during the following five years. In 1980, the U.S. Department of Education and the National Science Foundation reemphasized this shortfall which by that time had encompassed 28 states, 16 of them critically.[9,10] In 1981, the National Academy of Sciences reported that this shortage had spread to 43 states.[10]

Figures on unfilled positions alone do not accurately reflect the depth of this problem. The State of California reports that 1/3 of its math and science teachers did not even minor in those subjects.[11] In the Pacific Coast States 84% of newly employed math and science teachers were trained in other areas.[9] 79% of the nation's science teachers have not completed a 10 hour workshop during the past 10 years nor have 40% attended a course in 16 years.[10] In a 1981 survey of 60,000 science teachers, 50% had not been science majors and 51% of elementary school teachers had had no science training.[10] Somewhat more optimistically, the National Science Board's Commission on Precollege Science and Math Education recently reported training deficiencies in only 30% of all math and science teachers.[12] Lastly, the NCEE reports: "too many teachers are being drawn from the bottom quarter of graduating high school and college students. The teacher preparation curriculum is weighted heavily with courses in 'educational methods' at the expense of courses in the subject to be taught. Half of the newly employed mathematics, science and English teachers are not qualified to teach these subjects."[1] Fewer than 1/3 of U.S. high schools offer physics taught by qualified teachers.[13] In short, the shortage of <u>qualified</u> science teachers is greater than figures on "unfilled" positions indicate.

Contributing to this trend of increasing shortages have been declining rates of teacher production and increasing rates of defection. Of students entering college in 1966, 22% were education majors. Currently, only 5% are.[9] In 1972, 1064 science educators were produced.[10] Of these, Pennsylvania graduated 104 in physics and 146 in chemistry.[14] By 1980 these numbers had decreased to 672, 13 and 25, respectively.[10,14] (As if this decrease were not bad enough, current education majors have SAT scores 80 points below the national average at a time when the national average is at an all-time low.[8,9])

Science teacher defection conversely has increased. During 1980 for every 1 retiree, 5 defected. At current rates the U.S. will lose 1/3 of its science teachers by 1992.[9] (In comparison, the Soviet Union graduated more science teachers last year than are currently employed in the U.S.[15]) Both factors coupled with a rise in elementary students and an increase in birth rate are reinforcing. Shortages will increase into the

1990's.[9,10,14] Furthermore, if recommendations by the NCEE to increase science offerings are heeded, shortages will be compounded.

These shortages have already impacted upon Pennsylvania. "In 1981-82, 174 emergency certificates for teaching math and science in our public schools were issued to people who are not fully prepared to hold those jobs."[6] If each had taught only 100 students during the 1982-83 academic year, 17,400 students and Commonwealth citizens received questionable instruction in these areas. Again the problem is a combination of low teacher production and increased defection. In 1981-82 only 458 new certificates were issued in math and science.[6] Only 1/3 of these are still currently employed in education.[6] In that same year 654 math/science teachers left the profession.[6]

For that matter, the decrease in secondary school science teachers is only one part of and perhaps a contributing factor to a more insidious trend: a general decrease not only in college faculty in the sciences but also in the overall production and consequently employment of trained physical scientists. In 1969 math and science faculty comprised 14% of the total college faculty.[8] By 1975 this number had decreased to 7%. Shortages are most pronounced in computer science and engineering, but they are becoming noticeable in chemistry.[16] Vice Chancellor Theodore Brown of the University of Illinois has admitted that with the departure of ranking faculty to industry or better paying institutions (150 in 2 years), the University is struggling to survive as a first class institution. At the University of Wisconsin, twelve members of the Department of electrical and computer engineering have left in the past three months. After a 6-month search which had begun earlier, no replacements have been found. Berkeley has been unable to recruit the faculty necessary for a first rate genetics engineering department.[17] In spite of a salary offer of approximately $30,000 and the availability of $100,000 for research equipment in the area of analytical chemistry, the University of Nebraska is in the third year of its search for an analytical chemist.[15]

Close to home, Shippensburg University is in the second year of a search for a highly qualified physical chemist. Of 70 physical chemists seeking employment at the ACS clearing house in Washington, D.C. this month, only 12 indicated an interest in academe. Only in 4 cases was academe a primary interest. Yet besides S.U., a partial list of institutions searching for a physical chemist includes the University of Wisconsin, Fordham, Utah, Chicago, Dartmouth, CUNY, Yale and Pitt.[18]

Paralleling the trend in secondary education, shortages are arising through faculty defection and decreasing production of trained scientists.[16] In 1970, 15,811 chemists were graduated. By 1981 this number had decreased to 14,623. The greatest decreases occurred at the M.S. and Ph.D. levels, the levels normally required for advanced research and college teaching.

Compounding this decrease is the observation that the quality of students entering graduate school has been decreasing.[15] Relative to all college degrees, 17.2% of earned doctorates and 3.6% of earned B.S. degrees were in the physical sciences in 1964.[8] By 1976, these percentages had decreased to 10.1 and 2.3, respectively. Further decreases to 7.8 and 2.2 are expected by 1987.

In a high tech society the U.S. is producing less physical scientists and science educators both in quantity and quality. Unless actions are taken to reverse these trends, the results are obvious.

Solutions to problems require the identification of the causes of these problems. Fortunately, these have been identified by the NCEE, the U.S. Department of Education, the National Science Foundation, the American Council on Education, the American Federation of Teachers, the ACS, the National Education Association, the Pennsylvania Department of Education and local studies.[1,9,11,14,16,19,20] (Local input was obtained through interviews conducted since October, 1982. Besides interviewing chemistry teachers during an inservice workshop, discussions were also held with 7 former science teachers who left the profession and three who are currently planning to leave.)[19] The causes presented are not necessarily in the order of importance. Most sources agree that all will have to be treated simultaneously to effect an overall solution.

1. Noncomparable compensation - Most sources agree that the major cause for shortage of science educators appears to be noncomparable compensation. In terms of real dollars both educational and industrial salaries in the sciences have cycled with the economy, increasing in the 6 year period before 1974 and decreasing since then. Unfortunately, industrial salaries have lost less in recessionary times and increased more during economic booms, gradually increasing the differential between salaries.

   In 1982 beginning salaries for high school teachers averaged between $10,000 and $12,000.[9,14] Beginning salaries for B.S. chemists in the private sector averaged $17,000 overall and $19,000 in the manufacturing industry. The current starting differential is thus between $5000 and $9000. In 1976 this differential was $3000 with industrial chemists starting at $11,700.[8,20]

   Considering average salaries for experienced personnel, high school educators earned a few years ago an average of between $17,000 and $17,600 with little place to go.[9,13] The industrial equivalent averaged $28,500 with further advancement and increased salaries possible.[20] Similar statistics and arguments have also been invoked to explain the increasing shortages observed on the college level.[10,16,20,21,26] For example, in 1982 the median annual salary for Ph.D. chemists in industry was $42,000 as compared to $30,000 for those in colleges and universities.[20]

   According to census statistics, teacher salaries in Pennsylvania averaged $19,600 last year, ranking 16th among all states where the national average was $19,000. This of course does not take into account the cost of living differences inherent in an industrialized state nor does it reflect the loss of purchasing power between 10-18% over the past ten years.[22] It does, however, show that the average Pennsylvania

teacher with 10-15 years experience makes as much as a B.S. chemist just starting in industry. Perhaps this is why five of the seven teachers who left teaching for industry in our area cite salaries as the major reason.[19]

Paraphrasing reference 16: "people in education always will make less money than those in industry but there is a crossover point." Whereas small differences may represent an acceptable sacrifice, large differences may be unnecessarily suicidal. Somewhere between lies a crossover point which apparently has been reached. If we are to eliminate science illiteracy by recruiting and maintaining excellent educators, this differential will have to be decreased. Tuition aid to increase the production of teachers will only have a slight effect on production; it will do nothing to decrease the increasing defection.

2. Lack of Support

A. Equipment - In secondary and elementary schools, expenditures for textbooks and other instructional materials have declined by 50% over the past 17 years.[1] 36% of the nation's elementary schools have classrooms with no science facilities.[8] Only 50% of the nation's high schools have specific budgets for scientific supplies and equipment which average a meager $9.50 per student considering today's costs.[8] Considered a major problem by the nation's teachers,[8] lack of material support has not only contributed to increased defection but also to reduced quality.[1,9,19]

Lack of equipment is also the second major problem in higher education. In difficult economic times the standard solution is "doing more with less" through improvements in techniques and technology. Unfortunately, there are limits to these improvements and all too often a saturation point is reached where doing more with less translates into either "doing more things less well" or "doing less things more well." Unfortunately, the more expensive programs like those in the sciences must bear the brunt of this burden.

To cite a few examples, at the University of Illinois a study on semiconductors depends on water cooled equipment which malfunctions every time someone flushes a toilet.[26] The University of California at San Diego has identified the need for four computers at a total cost of 1.5 million dollars.[26] This is the equipment budget for the entire campus. The American Council on Education notes that across the nation laboratory and other teaching and research equipment are outmoded and that most universities possess equipment 10-20 years old which came with the building.[16,23] Whereas studies have only begun on SSHE through the PSC_3, so far only 1 institution has reported 1 capital equipment expenditure in chemistry during the past ten years.

Gone are the days when a $5 cloud chamber could examine subatomic particles. Now billions of dollars are needed for a Texas cyclotron. Equipment such as mass spectrometers and NMR spectrometers ranging from $40,000 to $400,000 are simply not being replaced. Not only are college faculty defecting to industry which has better equipment but also the quality of higher education is being reduced. Students are learning on equipment which industry no longer uses.

B. Moral Support - Support must also exist in nonmaterial ways. Administrators, parents and the entire community must support science educators and their efforts. A University of Pennsylvania study concluded that principals play a vital role and can improve education by providing a clean, safe environment conducive to learning and showing personal concern for teachers and their professional development efforts.[24] Yet within our area exceptions to this conclusion exist.[19] Chemistry teachers are required to spend their own time prepping laboratories without assistance. Unsafe laboratory enrollments of 40 students/teacher exist. Teachers with full loads are being asked to take on additional duties in the computer area. Teachers have not been allowed to design advanced courses in science. At least one chemistry teacher was not allowed to take 2 days off to attend an ACS short course in computer applications in chemistry which would have been paid for by the ACS and the teacher. This same teacher had been told to design his course so everyone could pass with an A, regardless of his math background. (He could just have easily designed football so that babies could compete with 260 lbs. guards.)

Support must come from the entire community as well. The Carnegie Foundation reports that schools rise no higher than the communities that surround them.[4] The Commission on Precollege Education in Math, Science and Technology of the National Science Foundation has concluded that "the absence of a national consensus or the importance of math, science and technology education for all citizens may be the central cause of the critical problems facing our educational system.[16]

The above causes are by no means all inclusive. Rounding out our list are:

3. low prestige and lack of respect
4. disciplinary problems
5. nonchemistry and "Mickey Mouse" duties
6. repetition and boredom

Science and science education today face many problems. Many more solutions have been proposed to deal with these, some of which are tabulated in the appendix. In the past our pleas have fallen on deaf ears, but today our Nation is awakening, listening and beginning to act.

Today you are asked to take part in this beginning. You are asked to begin identifying the nature and depth of these problems in Southeastern Pennsylvania and to propose solutions. The results generated today will play a major role in a second conference in November involving other leaders in government, industry and education. People will listen and hopefully people will act.

Will these reforms actually take place or will your efforts today and the efforts of others result in mere words which will fade like the signals of an ancient Sputnik? I don't know. All I can convey to you are the

comments of Jay Sommer, the lone high school teacher on the National Commission on Excellence in Education:[25] "First and foremost, I would like for my fellow teachers to rekindle their hopes. I know that in many instances their hopes and their aspirations and their enthusiasm have been shattered. For in the past few decades, we have overlooked the feelings of teachers: We piled incredible burdens on them and hurled unfair accusations at them. The teachers alone cannot settle all the ills of society. They need a lot more help than that.

There is no doubt about it: We are underpaid and underappreciated, and in my travels these signs show. The attack has been so cruel that teachers have lost perspective on why they entered the profession to begin with.

It is my belief that teachers start with idealism. But because of all the criticism of the past twenty years, this idealism has been crushed within us almost to the point where we don't believe in ourselves and the aspirations that we have. That's quite normal.

But I think that we have to be strong as teachers because our lot demands it of us. Many teachers ask me, "How do you keep up this feeling that you are important when no one-or only a few people-appreciate you?

My answer is that I learned how to appreciate myself for what I am doing so that the other appreciation, although I would like it, is of secondary importance. I know that without me or without those teachers thousands of years ago this world as we know it would not have been possible.

We are the army who wins wars against ignorance, the most important wars. We are very important soldiers because without firing one shot, we make a positive difference.

Basically, what I would like to pass on to my colleagues is an expression my mother used. My mother used to say, "Go one more mile." and there were times in the labor camps when I felt I couldn't go any more, but that voice that whispered "one more mile" has done so much for me.

Let's go one more mile and let it never be said that we didn't try."

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Time for a New Attitude

Mr. Joseph Sollenberger
Chemistry Teacher, Hershey High School
Cochairperson, Education Committee, SEPACS

"The next few years make the difference on whether I stay in education. This is the last chance." "The total budget for chemistry in my school was one hundred dollars for the 1983-84 school year." "Excess time spent on 'paper chores' detract from the real task of teaching." "I simply cannot prepare the labs, teach the classes, and carry out the other jobs expected of me in the normal school day." Such comments were commonly expressed during the meeting of local chemistry teachers held at Shippensburg University on 24 September 1983.

This conference began to deal with the concerns of chemistry teachers in South Central Pennsylvania, but it was apparent that more discussion is needed. The main themes were salary differences between education and industry, aggravations in teaching, lack of standards in pre-service teacher education, lack of inservice programs that truly benefit the teacher, lack of funds for facilities and lab oriented programs, and lack of a professional attitude towards educators.

PROBLEM 1 - SALARY

Why do college graduates choose not to enter the teaching profession and why do experienced teachers leave the profession? Many times the answer is the low pay. The longest discussion of the conference dealt with the problem of the salary in education. Our society dictates the vacation pattern of the public schools and this has much to do with the problem. Many people envy the 'vacation' of the teacher in the summer, but teachers will quickly point out that it is not a paid vacation and it is forced upon them. One state official has pointed out that the average college graduate in professions other than teaching work an average of 218 days per year. The average teacher works 185 days per year. The gap between days worked per year is not as great as many imagine.

Many recent college graduates enter industry at salaries that exceed the maximum salary a teacher may earn. In a local school district a teacher with two master degrees and thirty-one years of experience earns a maximum of $20,700. Many science teachers would like to work at summer jobs that use their technical skills. It is possible to negotiate a contract that will pay for curriculum work and study during the summer months, but few schools do this. Perhaps local industries could hire science teachers during the summer months. One local college is planning a summer intern program for chemistry teachers to work with the faculty on research projects. Another possibility is a lectureship program for outstanding public school teachers to be associated with a college or university.

A differential salary system was discussed. Many school boards look at the salary costs as a total package that may be manipulated in various ways so that the total package is not increased. One local school district offered its science teachers a bonus of $2000 each. This bonus was refused

by the science faculty because it meant that the other teachers of that district would have paid for the science bonus by taking a lower raise. Such proposals drive a wedge between disciplines in the schools. Many teachers do not view a differential salary as a solution to a supply and demand problem but view salary differences as a statement about the intrinsic value of their work.

The salary problem is beyond the scope of the local school districts with their property taxes. Because the schools are often the only governmental agency over which the citizen has any control, the schools often serve as a scapegoat for the frustrations of the taxpayer. The buck stops before it gets to the local school! New methods to finance education must be found.

PROBLEM 2 - AGGRAVATIONS

Aggravations that cause experienced teachers to leave include: the poor study and cognitive skills of the students, paper work that does not enhance teaching, large class size, and the number of preparations and classes taught. Some of these problems could be solved by school districts hiring more faculty, but that means a larger budget and we are back to problem one. It is interesting that an article in Fortune Magazine discussing the problems in education suggests that schools hire good people, set standards, and let them teach. The article further adds that teacher salaries have not contributed much to the increased budgets of the schools but increased bureaucracy has.

PROBLEM 3 - TEACHER TRAINING

We need to upgrade the standards for entry into the profession. Many of the teachers at the conference were chemistry majors and are concerned that there has been dilution of the standards since they entered the profession. There is also concern that a program such as Temple University's plan to retrain teachers from other disciplines to teach science and math will not produce the quality product the public now expects. It now appears that one may teach chemistry with fewer chemistry courses than that required for a chemistry minor. Let us not return to the days when one general chemistry course in college was adequate preparation to teach high school chemistry. It never was adequate and it is even less adequate today.

Some have suggested that college students who prepare to teach in the math and science areas have their college loans excused if they take jobs in public education. Members of the conference felt that this was not the solution since many of these new people would seek jobs in industry when the loans were paid. A young chemist who recently graduated with certification to teach in the high school took a job with industry because he could not accept the poor offers presented by the school districts. If we wish to attract new people into the profession, we must compete with industry with respect to wages, benefits, and working conditions.

PROBLEM 4 - INSERVICE PROGRAMS

Most of the inservice work and graduate credit work was seen as a waste of time. One good program was an evening of demonstrations held by the Lancaster-Lebanon I.U. The Canadians appear to be serving their secondary teachers much better by sponsoring summer institutes and Saturday workshops. The University of Waterloo and Queen's University are noted for their work in this area. We have the facilities and personnel to provide such programs for our local area. The Dreyfus Institute is a good model for us to copy. It is also possible that short courses presented by the ACS could be given in our local area. Industry could offer workshops on lab safety, chemical storage, and chemical disposal.

PROBLEM 5 - FACILITIES AND PROGRAMS

We lack standards concerning lab safety, course content, class size, course load, and lab experiences. Who would set these standards and who will pay to implement them? The group was divided on the issue of standard exams patterned after the system used in New York state. It is interesting to note that "the much maligned curriculum improvement movement of the 1960's does not seem to be the cause for the decline in student performance . . . students who have studied from the NSF-funded curricula score considerably higher on achievement tests than those in traditional groups." [From J. of College Science Teaching, Vol. XII No. 1, pg. 48.] People from high schools, colleges, and industry should work together again and revive the enthusiasm that was so characteristic of the NSF programs.

The American Chemical Society has not forgotten the high schools. The "Guidelines and Recommendations for the Preparation and Continuing Education of Secondary School Teachers of Chemistry" published by the American Chemical Society in 1977 is a good source of information and suggestions. In this report we find recommendations

- to the secondary school chemistry teacher
- to college and university teachers
- to state and regional educational officials
- to local school officials
- to state and local agencies, organizations, and industries
- to national organizations and agencies
- to professional teacher organizations.

Much of the work has already been done by the ACS to attack problem areas 3, 4, and 5. These ideas apply to other content areas as well. Let us carry out these recommendations even if we are six years late.

PROBLEM 6 - ATTITUDES

Many words are spoken and printed extolling the importance of teachers and the teaching profession. These words are especially evident during the opening of the school year, during inservice days, and during commencement

exercises. Recently it has been popular for Presidential Commissions and Blue Ribbon Panels to write such words. I am convinced that the teaching profession is both honorable and important. However, I am also convinced by words spoken to me, by words spoken at the bargaining table, and by observations of "real life" that teaching at a high school is not viewed as an important profession. I do not like to tell people that I am a high school teacher because of the negative response I usually get. It is much better to say that I am a chemist interested in secondary education. This is an especially effective line these days. Let us be honest and admit that physicians, research scientists, all types of engineers, professors, businessmen, and anyone who knows anything about computers are held in high esteem. I want very much to be a valued member of the community, but I'm in the wrong profession. Secondary education does not have a good image.

We must also admit that money is a measure of an individual's worth in our society. Academe has always had a lower rate of pay than industry, but the problem is more significant now because teachers are heeding the advice of those at the bargaining table who told us to get out of teaching if we didn't like the pay. That has been good advice. Please remember this. The effect of high praise comes to naught when at the bargaining table we are told that we could all be fired and be replaced by people off the streets who would be very pleased to have our jobs. This is the true attitude of the public towards the teaching profession as presented by our employers, the boards of education. I find this business of adversarial relations at the bargaining table most disgusting, but the legal dance played at negotiations time almost demands it. It is a rare community that can work out a contract in an atmosphere of trust and understanding. This is the first time I have spoken openly about my feelings concerning negotiations. It is this business of double standards that I find most distressing. My observations of events in several communities during school contract negotiations has taught me how teachers are really valued. Because of this I cringe when I hear the high sounding praises spoken on opening day, inservice day, and commencement. Because of this I do not like to tell strangers I am a school teacher. I have little hope that the general public will ever hold teachers in high esteem if the present attitudes prevail.

These are deep and intense feelings that have been developing since I observed public behavior during a 1973 labor dispute in the school district I attended as a child. That was Western Pennsylvania, but it is no different in the 1980's in the community in which I live in Eastern Pennsylvania. Despite this I still teach, but at the local barber shop I will never let the local crowd know I am a teacher.

We who are at this conference today value education. We must work to convince the others of society that education is important. Consider how communities spend their local resources. Consider how individuals spend their money. Those who value education are in the minority. We have much work to do. Work actively in your communities to establish higher standards and better environments in the local schools. We must work person by person, neighbor by neighbor to change attitudes in our local school districts. Parents must be convinced that good attendance patterns

are necessary for academic success. The public must seek the positive aspects of their local schools and be pleased about the good things. The community must work together to eliminate the problem areas instead of just allowing the problems to divide the community. It will not be easy, but we must stop making the local schools the scapegoat for the community ills.

RECOMMENDATIONS

Personally I wish to see three things happen in 1984. I want local industries, colleges, and universities to involve local science and math teachers in programs at their sites. I want the local science and math teachers to organize themselves to share materials and ideas. I want all of us to monitor the actions of our local school districts to make sure that the recommendations of the various studies are being implemented.

It is important that we work to improve the self image of the secondary school teacher. Industrial, college, and university contacts will convince the secondary teacher that he is part of an important team. College students are often hired during the summer in intern programs. These programs motivate the student and help defray tuition costs. Such intern programs would motivate teachers as well. This excitement about their subject would help in the classroom. If a salary could be paid, it would help with the salary problems. The main outcome of such associations would be professional pride and mental stimulation. Help our teachers become enthusiastic about their subject areas.

We teachers must also motivate ourselves. Let us make plans to meet to share exciting ideas and techniques. We can't expect others to make the arrangements for us. I am ready to work with anyone who is interested in arranging some swap shops. Computer user groups are very popular. I propose we form a users group for chemistry educators. Let us meet and share what we have learned about computers in the classroom.

Let us make sure that our local school districts provide excellent programs for all students not just the academically talented. Good programs cost money. Make sure your local schools are not cutting corners in the academic areas so that the budget may be balanced. In the sciences this means that laboratory facilities and equipment as well as double periods of time in the lab must be supplied. Also make sure that the teachers schedule allows enough time for laboratory maintenance. Few administrators appreciate the special demands of operating a chemistry lab and the time required. In short, see that the ACS recommendations for secondary chemistry are carried out. Other disciplines have similar recommendations. See to it that these are carried out. Don't allow conditions to remain as they are!

CONCLUSION

The group at the September conference did not find many specific, rational solutions to the problems discussed and there are many more problems that were not discussed. It appears that many of the concerns expressed at the conference are beyond the control of the local school

districts. The solutions require cooperation and imaginative thought among many groups of our society. The recent publicity has produced some hope that conditions in secondary education will change. We teachers have been often told that we did not have to become teachers, and if we do not like the conditions we may leave. We are following that advice. The present college students are following that advice. When we have all followed that advice who will teach chemistry in the high school?

Science Education and the American Chemical Society

Dr. Keith Peterman
Chairman, SEPACS

Last year, a 5th grade boy whom I know quite well was puzzled by a statement in his science class. The class was studying simple machines at the time and reference was made to incline planes in a gear box. This young boy has an aptitide for science and a fancy for cars, but from his investigations he had never seen an incline plane in a gear box. He told me that when the teacher wrote it on the board he couldn't write it down because it wasn't correct. I asked him if he had challenged the statement; he had not! The next day he indicated to me that when he challenged the statement in class he was told by the teacher that the answer book said there was an incline plane in a gear box. The story does not end here nor did it begin with the incline plane and the gear box. Through it all, this boy began to lose confidence and interest in science. Fortunately, his interest and enthusiasm were rekindled the following summer when he audited a chemistry course. He performed well showing remarkable competency when challenged. He is by no means a precocious child; rather, he is simply a young mind interested in science.

Albert Einstein said "One should never cram young minds with facts, names, and formulas. To know them you have no need of university courses, you can find them in books. Education should only be used to teach young people to think and to give them this training which no textbooks can replace. It is really miraculous that modern education has not completely suffocated the sacred curiosity of research. I believe that one could even cure the wild beast of its voracity if, under the threat of the whip, it was made to eat when it was not hungry and above all if one selected the food one forced it to swallow".

We are all gathered here today in an effort to help turn the tide on declining science competency within our nation. Hopefully, the young boy I mentioned, and many like him, will survive the whip and their sacred curiosity will be nourished, not suffocated.

As an educator, chemist, and parent of four children, my interest in science education covers the spectrum from undergraduate through elementary school. I have been involved in providing enrichment activities for small groups of gifted elementary and middle school students from York County. The most recent project involved two sessions on a Saturday in October when I hosted a group of 5th and 6th grade students in the morning followed by a group of 7th and 8th grade students in the afternoon for a laboratory experience in chemistry at York College. The chemistry sessions represented only one Saturday in a five week enrichment program for these youth. The other sessions included theatre, South American culture, and computers. I might add that chemistry was back by popular demand following a similar enrichment program in the spring. The objective of the chemistry session was to acquaint the students with physical methods used in the chemistry laboratory. The students experimented with a bunsen burner, vacuum filtration and fractional distillation. Following a brief introduction, they set-up their own apparatus and performed the experiments with only minimal

assistance. It was very interesting to observe the confidence, competence, and independence of these children in the laboratory. The feedback from parents and the students was, as before, overwhelmingly positive. Expansion of the enrichment program to include multiple chemistry sessions is being considered.

As an individual chemist, I have enjoyed interacting with pre-high school students on many occasions. Many of the 500 American Chemical Society members in the Southeastern Pennsylvania Section have, as individuals, in like manner contributed their time and professional talents to science related community and educational activities. However, as an organized group, the local section has done little to support elementary or middle school science education within our section.

A recent ACS report on chemistry in the kindergarten through 9th grade states that "the amount of quality of K-9 science presently taught in the schools is insufficient for a technological society, and is insufficient to meet basic academic goals".[1] The report, however, indicated that solutions are definable and implementable, given suitable efforts by groups associated with science instruction (such as ACS). As is the intent of today's conference, the recommendations were intended to stimulate thought and action. Recommendations directed to local ACS sections include:

1. Develop "locater lists" of retired chemists available as resource persons to assist elementary and secondary school science teachers.
2. Augment science reference resources of schools and public libraries.
3. Initiate awareness programs to alert the professional chemical community to the current status of school science at the local level.
4. Encourage members to be active in local PTA's and school boards to improve science instruction.
5. Expand award programs to include recognition of elementary teachers who excel in science instruction.

These recommendations are realistic and can be implemented by our section. Along with additional specific recommendations which emerge from this conference, I will forward these recommendations to appropriate committees for review, planning, and implementation.

Although the southeastern Pennsylvania ACS section has been deficient in its support of elementary and middle school science education, it has been active on the high school level. Our local section supports both the Lancaster Area and Capital Area Science and Engineering Fairs via independent judging with cash awards and certificates being presented to winners. Each year, we invite the science fair winners, high school chemistry teachers, and two outstanding students from each high school within our section to attend the annual education night meeting. Each student is recognized with a certificate. As a high point of education night, the Whalen Award, consisting of a plaque and honorarium, is presented to an outstanding chemistry teacher in the section. Several Whalen Award recipients are in attendance today - a fine tribute to their concern for science education. Chemistry students from each of the 11 colleges within our section are also recognized at education night with a certificate, and each receives a professional journal subscription of his or her choice. Last year we

implemented a scholarship program providing $500 each year to a senior chemistry major from an ACS approved college chemistry program in the section. Our awards committee remains quite active.

John Grezlak, a coorganizer of todays conference, along with Joseph Sollenberger, is chairman of our education committee. His efforts won support of the local section for this conference and he drafted a $1,000 grant proposal currently pending with the National ACS Office to support publication costs for today's proceedings.

Perhaps the greatest benefit the local ACS section can provide for many of you here today is collegiality. For me, as one of only four fulltime chemists at York College, I occasionally feel professionally isolated. However, the monthly ACS meetings afford me the opportunity to interact with colleagues from both industry and education. I would strongly encourage any qualified individual in attendance today to consider membership in the ACS for this reason alone.

On the national level, the ACS becomes an awesome resource for any concerned science educator. I fully intended to serve a full-course meal regarding the activities of the National ACS office; however, with the time allotted, I can do little more today than offer you a cold hors d'euvre. On the national level, the American Chemical Society is a focal point of chemical research and education. The key to the world's chemical literature rests with the chemical abstracts service provided in both hard copy and as a computer on-line service. The society publishes two dozen journals and magazines touching virtually every area of chemical interest. It carries forward such a broad range of activities that no attempt will be made to even consider a comprehensive survey. Rather, I will address several activities that may be of special interest to high school and middle school educators.

During the past five years, interest in high school education has taken a quantum leap on the national level. In 1979, a new Office of High School Chemistry was established. This office administers four programs:

1. High School chemistry.
2. "CHEM MATTERS"; a news magazine for high school students.
3. Career services.
4. Project SEED: a high school/career program that places economically disadvantaged high school students into summer employment in academic laboratories.

The most notable of the Society's publications for educators is the Journal of Chemical Education. It devotes an average 20 pages per month to high school teachers. A high school newsletter, "CHEMUNITY", is distributed free to over 8,000 high school teachers providing them with information on past, present, and future activities of the society. Just this fall, regular subscription issues of the new high school magazine "CHEM MATTERS" became available. The society also publishes secondary education guidelines for health and safety, curricula, and teacher preparation.[2,3] The Society sponsors regional workshops for high school teachers. Teachers may borrow at no charge films and video tapes from the high school library. My recommendation for the individual educator is to directly contact the Office of High School Chemistry regarding any concern.

For the middle school science teacher, the ACS prepared a curriculum enrichment unit entitled "Combating the Hydra." This module contains lesson plans and materials designed to integrate science and society materials into the general science classroom.

Continuing education courses covering a broad range of subjects are available in four basic formats. These include: live session short courses, audio courses with texts, video tape courses, and, most recently, interactive computer courses. Our local ACS section would consider underwriting the cost and planning a short course in this area provided adequate enrollment is guaranteed.

Where does the society go from here? Dr. Robert Parry, past national president of the ACS, recently presented a testimony before the U.S. Senate Committee on Labor and Human Resources.[4] The testimony presented fourteen principles concerning the involvement of government and institutions of math, science, and engineering in pre-college through post graduate education. Several points of direct interest to the pre-college educators include recommendations for federal funding to allow current teachers to upgrade their subject matter competency, a recommendation to raise teacher certification requirements, and recommendations for curriculum improvement. Retraining of teachers and upgrading of subject matter knowledge was given high priority.

The society currently has a major study under way to assess the condition of chemistry education in this country, from kindergarten through the post graduate level. The task force for the study is divided into three panels addressing chemistry for citizens, chemistry for non-chemist professionals, and chemistry for chemists. A preliminary report of the task force summarized the large number of recommendations to be forthcoming.[5] These recommendations cover items such as granting science the status of a basic area of study in the elementary school through establishing science requirements for graduation from college. Tangible activities such as increased salaries, improved working conditions, fellowships, endowed chairs, and summer workshops are recommended. All point toward improving both quality and quantity of science education in all areas of our society. A copy of the preliminary report is appended to this text.

May I conclude on a personal note. All little boys and girls have heros. As we mature we seek role models. I call them "giants." I have two giants who have significantly impacted my life's journey. Both were educators. One was an undergraduate chemistry professor. The other was my high school chemistry teacher.

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Excellence in Science Education

Dr. Anthony Ceddia, President
Shippensburg University

It is with great pleasure I welcome all of you to Shippensburg University. I especially appreciate the opportunity to share some comments and thoughts with you about the very important matter of science education, especially about the teaching of chemistry.

I am somewhat embarrassed this morning because I am reminded that if my father were alive today, he would be sitting in the audience and chuckling. He was a very effective chemistry teacher in his day. In fact, he wrote a high school science textbook, which contained a strong section on general chemistry.

Like most fathers, he thought I would follow in his "scientific" footsteps. However, when it became painfully obvious early in my high school career that I would not succeed in a science discipline, my father became very supportive of my interest in the education profession.

Regardless of my questionable science skills and background, I do welcome this opportunity to talk to you this morning about higher education and in particular about the role an institution like Shippensburg University can and should play in the areas of science education, educational quality, and the teaching of chemistry in high schools.

As I begin my comments, please permit me to set for you the overall course which I intend to follow. I would like to speak this morning not about the American Chemical Society and not about a lot of statistics which reflect what is happening in the discipline of chemistry. Rather, I would like to focus on what I consider to be an approach that might help us cope, in the long range, with the problem of science education, particularly in South Central Pennsylvania.

I suggest we attempt to view the problems we face not just from the perspective of the chemistry teacher. In my opinion, the difficulties we face have their roots throughout the country, including the Commonwealth of Pennsylvania, in local communities, schools and colleges. Neither the American Chemical Society nor its local chapter in the Cumberland Valley will be able to solve the problems because I do not think that teachers talking to teachers about their disenchantment with the profession will overcome the difficulties. In addition, I do not believe that problems will be solved by well-meaning politicians, who just happen to jump upon the political bandwagon for better education and a need for a resurgence of science education simply because those issues are timely.

We must recognize that we are dealing with a complex situation which will require long-term commitments from government and people before there are any solutions. Everyone involved in the educational continuum--on the national, state-wide, and local levels--has to work together in order to develop long term solutions to the problems of science literacy, science education, and even the teaching of chemistry.

Recently, I had an opportunity to review summary statistics developed from a survey conducted by the Pennsylvania Department of Education. The survey investigated the supply and demand for teachers of science and mathematics in Pennsylvania. Basically, the survey results indicated the Commonwealth of Pennsylvania has enough math and science teachers at the present time. By 1990, however, increased student enrollments and the retirement of significant numbers of math and science teachers currently employed will cause difficulties.

I mention the Department of Education's report because it is typical of the many documents we find ourselves reviewing today in education. The report describes numbers. It alludes to possible shortages. It refers to the emergency certification--licensing--of teachers in certain disciplines. The report, however, does not deal at all with educational quality. Nor does the report focus on the important issue of curriculum. Finally, and most important to me as an educator, the report does not discuss teaching competence.

As a faculty member and an administrator, I always have been concerned about the art and skill of teaching regardless of the discipline. Some of the problems we face today, for example, in the field of chemistry and the other sciences, are evident throughout the curriculum from K to 12 and even at the collegiate level. I do not think we are dealing in chemistry and the other sciences with conditions that are unlike the circumstances which exist in other academic areas. I am suggesting this morning that even though as chemists and as scientists you are genuinely concerned about what is happening in your discipline, you do not lose sight of the fact that there are similar problems in other disciplines in education.

How do we deal with these problems? How do we get at these problems? What approaches do we take to solve these problems?

Well, I do not want to push the problems into someone else's yard. However, even though I do not have a myriad of solutions and alternatives to put before you this morning, I do have some thoughts, ideas and reactions that I would like to share with you. My comments, I hope, will help motivate you in some new directions or assist you in seeing the problems we face from a new and different perspective. From all of this, perhaps we may be able to do more to improve things.

In Pennsylvania, like in many other northern industrial states, the economy is in transition. The state's economy is moving from what is considered to be product-based to an economy that is technological and knowledge-oriented. If you know much about the economy in Pennsylvania, you are aware that, at the present time, the economy is not as good as it could be and that the economic base in the Commonwealth needs more time to change.

Most educators are concerned about the economy because they are worried about the funding for schools, colleges, and universities. I, too, share this concern. .However, the changing economy is also signaling that the Commonwealth of Pennsylvania is going through a sociological transition

as well, which means that the students we are now educating need to be able to function in a very different environment than those who came before them.

In fact, if the economic well-being of Pennsylvania is to continue to improve, as it does in other northern industrial states, we in education must be more interested in and concerned about the quality of students leaving our institutions. Therefore, it has to be the total educational experience that is given our fullest attention.

When I read about or listen to discussions on quality in education, there seems to be more of a focus on the content of academic courses. More people are suggesting that schools and colleges require students to spend more time on certain subject areas. I do not disagree with this recommendation, but I do have some minor reservations.

What troubles me is that we are not talking enough or studying more about how academic subjects are being "delivered" or taught to students. By this I am referring to the kinds of teaching and learning strategies that excite and motivate students. Furthermore, I believe we are not focusing enough on the things teachers and administrators should be doing to improve the learning climate in the schools. Of much importance is the fact that there needs to be more discussion and action by the local community in support of academic excellence.

As educators, particularly as science educators and chemistry teachers, you have to assume the primary responsibility for making learning exciting and meaningful. This excitement has to become contagious among your students, but it is here I believe we are failing most in science education and the teaching of chemistry.

There are many qualified and committed teachers of science, especially of chemistry, in the profession. Nevertheless, I am not sure these professionals are spending enough time and energy on <u>how</u> science disciplines should and could be taught in order to increase a student's motivation and learning. A recent study indicates that if a student is not "turned on" and tuned in to" the sciences by the late elementary years, the prognosis for later science achievement is not very good. This study unequivocally sets forth the importance and significance of the elementary years in the science education process.

I have believed for years that as a nation we have been inadequately preparing elementary school teachers in all science disciplines and in the art of science teaching. Much more has to be done in elementary teacher-education programs to improve these conditions. A problem that must be tackled is the one that arises because many future elementary education teachers carry with them to higher education deep-seated anxieties and problems they themselves experienced in science and mathematics. This is a situation that makes the whole crisis even more complex.

Today we talk about increasing and retaining the number of science teachers, especially those teaching chemistry, by increasing salaries and by improving the teachers' professional sense of worth and status. I agree with and support all those objectives. However, I urge that we also concern ourselves with the quality of instruction--teaching strategies and techniques--which science educators, especially chemistry teachers, utilize in the classroom. I am convinced it is through quality instruction that you lay the foundation for productive learning and simultaneously ignite a student's interest and motivation in a discipline.

At this time, I also want to highlight some of the other things that we can do to improve science education and the teaching of chemistry. I have no easy answer to the national dilemma we face in science education, except that I believe the federal government does have a role to play beyond just providing rhetoric. There is a genuine need for direct financial support for science education to schools, colleges, and universities throughout the country. I am somewhat perplexed by the behavior of the current administration in Washington, which at one time tells us that we must be committed to excellence in our schools, especially in our public schools, and then in what almost seems the same moment supports a voucher system (tuition tax credits) that would undermine all of public education. Furthermore, the administration continues to work to dismantle the federal Department of Education, which supports in many ways the activities of higher education and basic education throughout the country. Even more important is the fact that department-level status for education keeps it in the mainstream of national policy development.

I am not suggesting that the federal government control education. I would be the last person to suggest this. Filling out endless forms is not productive. But, if you examine the resurgence of science education in this country which occurred in the late '50's and early '60's, the federal government, through the National Science Foundation and other government agencies, had a significantly positive impact on science and technology throughout the educational continuum. Ladies and gentlemen, I suggest to you that this type of federal involvement has to be re-established today if we are to achieve what is required in the sciences.

At the state level, there is much to be done, but the work has already begun. There is a strong movement to strengthen curriculum requirements in high schools, particularly in the areas of science and mathematics. The Secretary of Education for the Commonwealth of Pennsylvania has recommended these new requirements to the State Board of Education and these new requirements, I believe, are a move in the right direction.

I caution, however, that focusing on course requirements and content does not necessarily improve the quality of teaching. In fact, the Commonwealth of Pennsylvania recognizes the importance of the art of teaching. There is considerable discussion now taking place about strenghtening teacher certification requirements. I remain unconvinced that everything is being done in the present certification process to insure quality. Furthermore, teacher training institutions, like Shippensburg, have to continually assess and improve teacher-training programs.

Within school districts, at the local level, the issues of science education and the teaching of chemistry are perhaps even more perplexing. I empathize with those among us today who have spoken to the need for, and the all-too-often lack of, community commitment to the sciences. Many of the speakers are accurate when they talk about a double standard. During election time, local school board candidates strongly advocate quality education, especially in the sciences. However, when it comes time to make hard monetary decisions about funding education, these same individuals shrink from their earlier public commitments.

At Shippensburg University, there will be in the next few weeks an initiative to improve the awareness of new school board members of their important role and responsibilities. The University, in cooperation with school superintendents, will be running an orientation and education program for new school board members. It is important for new school board members to have opportunities to talk with educators--superintendents, professors, and teachers--in addition to getting the "party line" from the state-wide school board organization. Hopefully, the discussions at the Shippensburg University meetings will help new school board members to understand better the linkage between the kinds of decisions that are made at board meetings and the quality of education in their communities. And, I suggest to you that this is another way we can make community leaders aware of the importance of the sciences, particularly of chemistry.

Additionally, Shippensburg University will be attempting to improve community awareness regarding the importance of quality teaching, especially in the sciences, with the implementation of distinguished teachers program. Through a committee composed of teachers, professors, and superintendents, the University will publicly recognize outstanding elementary, junior high and senior high teachers. I am very excited about this new program because through it we will recognize and reward quality teaching in the schools and in disciplines like chemistry. Once identified, the outstanding teachers will be invited to the campus to work with University faculty as visiting lecturers and perhaps research assistants.

In another area, I am looking for the University to improve its role in science education. I have long believed that preservice programs in elementary education should place more emphasis on science education. Too often, educators overlook the importance of what happens in the elementary school classrooms. I have said to various groups many times that if they really want to improve the quality of education in the Commonwealth and throughout the country, they have to begin in the elementary schools. It is here that the foundation for all learning is established. Students are turned on or off to learning in the elementary school classroom. In these classrooms, students develop or do not develop the basic fundamental skills in English, mathematics and science, which are so important to learning activities in junior and senior high school.

Therefore, I am confident that as Shippensburg continues to refine its elementary education program, the University can have a significantly positive affect on the teaching of all subjects in the elementary schools. Moreover, the University will continue its heavy commitment to the in-service training of teachers in the field. Given the present concern with science education, and especially the teaching of chemistry, you can be assured that the University will make a special effort to work with high school teachers in the sciences.

Shippensburg University must also look to its role in the future regarding the importance of science education. For example, the University's science faculty needs to link more directly with science faculty at the high school level. The University also should be working with scientifically gifted students from various junior and senior high schools in the region.

Last fall, I reacted to an academic program review of the Chemistry Department. Several of the faculty from the department are here today. In my review, I expressed strong interest in establishing linkages with outstanding chemistry faculty and students at other levels of the educational continuum. I know the Chemistry Department shares this interest. Therefore, I am confident that over the next few months, Shippensburg University will be undertaking some new directions and responsibilities in the quest to improve science education and teaching, and, of course, I am pleased with these new initiatives.

All of this is not enough, however. It is only of small assistance to what is a major problem. There still needs to be a recognition, more of an awareness, that schools and colleges have to come together. For too many years, in my opinion, there has been a false status problem between schools and colleges. What I mean is that faculty at colleges and universities have been unwilling to engage in meaningful educational partnerships with teachers at the high school level. I would like to believe in the years ahead, particularly in the South Central Pennsylvania region, that it will be possible to bring together science educators from high schools, colleges, and universities. Through well-planned programs, these groups can interact about curriculum, teaching, and research, and at the same time reinforce their commitment to their disciplines and the education profession. Another outcome of these sessions could be the sharing of interesting and innovative ideas. This is significant because creativity and ideas are too often neglected in the education profession.

Certainly, there is more than can be done beyond my suggestions and reactions. Please be assured that Shippensburg, as your regional university, will do everything it can to improve the quality of science education and the teaching of chemistry.

Walt Whitman once said, "The public is like a beast, you have to keep beating it with a stick to let it know you are still there." The problems in science education and the teaching of chemistry will not disappear overnight. We have to keep working at solutions while constantly reminding the public that it has a problem.

I ask that you leave here today with a renewed spirit and an even stronger commitment to science education and the teaching of chemistry. In addition, I want you to leave possessing the confidence that Shippensburg University will work with you as a fellow ambassador in the struggle to seek support for the sciences and the teaching of the sciences. No person can do it alone. It sounds trite, but we have to work shoulder to shoulder to make improvements and, more importantly, to make the general public aware of the implications of the problems.

There is much to be done, but through partnerships for action much can be accomplished. I look forward to working with you. Thank you for your attention.

American Resourcefulness and the Science Education Crisis

Paul E. Bell, Contact Person, Science Education
Division of Curriculum and Instruction
The Pennsylvania State University

It will never go away. The unity of effort which characterized World War II did not include serious attention to science education in the nation's schools. Neither was science education a serious concern during the Korean Crisis. The Vietnam action lacked both American unity and national commitment to science education. Instead, we were attending the more dramatic game of a space race. But, as the space race continues as one of the features of the cold war which will always be with us, so will the current dilemma continue. Communications technology has made international economic competition a permanent fixture. The high demand for science and technological competitiveness will never go away.

Similarly, the tradition of industrial dominance by the northeastern U.S. is a thing of the past. Modern industry and commerce will depend more on suppleness and non-production based services. Last year 17 million of the 19 million new work opportunities were devoted to not making things (1). We are looking at a permanent condition of change (2,3,4). Last year AT&T spent $1 billion dollars on training and retraining to meet its changing technology (5).

A number of the proposed solutions to the declining test scores and reduced enrollments in the physical sciences are no-win suggestions over the long haul. For example, to argue the merits of merit pay for teachers, or special salary increments for science teachers will dissipate funds and energy into the fight when they would be better used for more creative alternatives. Regulations usually inspire reactions aimed at subverting the specifications and missing the reasons for the mandates.

I am suggesting that we use a triage concept - ignore those who can help themselves or those who are beyond help, and put our efforts where those efforts will actually make a difference. It is like the tiger who views baboons as a delicacy. Why should the tiger bloody himself attacking a baboon highly endowed with fangs when a toothless morsel will taste just as good. Let us seek to go with the elements of the situation that don't defy us.

The Problems

1. Lack of interest in the sciences by the non-college bound student.
2. Identification of incorrect grade levels as the targets for change.
3. Inappropriate aspirations of students and their parents for the need for schooling.
4. Teacher shortage.
5. Out-of-date teacher background.
6. Ignorance of the real nature of the hardware-software-human interaction needed for excellence.
7. Standardization of technological hardware.

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8. Lack of sufficient high quality educational software, including courseware.
9. Misdirection of efforts for funding sources.

Some Thrusts for Solutions

Student Problems 1, 2, 3:

a. The basic thrust of science education should be teaching students how to learn science for themselves. Industry will continue to train the responding learner and the one who takes the initiative to make himself or herself ready for new learning. The others will find their jobs discontinued.

   A number of the vocational technical career training programs are inaccessible to many of the students seeking them because of inadequate, authentic mathematics and science skills. In the future, according to the national Hi-Tech Task Force, the same sequence of courses, taught differently but with more understanding, will be expected for college and non-college bound students alike (6).

b. The main effort should be for students in grades five through eight. High school students have already tracked themselves either into or out of technical opportunities. Enrollment in high school science courses are prompted by interest and accomplishment in sciences in the earlier years. A larger pool of willing recruits will produce a larger pool of technical workforce.

c. Aim curriculum and instructional changes at the non-academic student. This holds for younger or older youth. Studies over the last decade show that half or more of the college sophomores, much higher proportions of high school students, and still higher proportions of younger youth cannot engage in formal, symbolic learning without additional first hand experience with the concepts. We're talking about hands-on learning where the message is implicit through manual manipulation of the materials. Moreover, our current adult population engages most of the time in tasks that do not require formal learning skills. However, the information age will demand increasing proportions of formal operations in daily tasks.

d. Since mathematics is formal, and science equipment is atypical of experiences most younger youth see every day, the science, mathematics, home economics, and industrial arts programs should be team planned and delivery should be coordinated to provide meaningful, concrete experiences. Home maintenance and repairs provides everyday examples for problem solving using virtually every science concept, every science process, and most of the mathematics that future work forces will need to become technically supple.

e. Moreover, these same students should use these experiences as one of the bases for their language arts development, and papers should be written and edited by the students using word process functions or computers.

f. Special attention should be given to having students work with gradients, rates, concentration changes, and other concepts that are based on continuous mathematical measurement.

g. The microcomputer should become accessible to each student for deducing algorithms through programming. The student should be able to pre-examine solutions to practical problems by observing the computer derived consequence of simulated changes in variables.

h. Inexpensive microcomputers should be used to monitor continuous data generation from various measurement devices.
i. Students should be counselled and prepared to consider self-employment as an addition option to "getting a job." Junior Achievement types of programs should be encouraged.

4. Teacher Shortage
   a. We may never again have enough qualified physics teachers in all schools. Therefore, we need to offer physics in other ways, such as public television courses for credit, or correspondence courses for credit. The other fields of science will be a concern if HB 1181 passes; otherwise need for the next five years will be met by the identified supply (7,8,9).
   b. Anyone who knows physics can tutor willing students in their homes just as the piano teachers now offer piano instruction. No credit. No certification. No guarantee. No institutional headaches.
   c. Offer possibilities for credit by examination, as is now practiced in colleges.
   d. Offer adult education courses in physics during the evenings for students aged ten and above. No credit. Continue on the basis of client satisfaction.
   e. Through Intermediate Units or local industries or school districts, offer science courses so that after proficiency is accrued, teachers can test out of prerequisite courses and continue on in a prescribed certification program courses.
   f. Expect each science teacher to recruit a science teacher each five years (about 1/school/year). This will keep a constant supply of teachers to replace those who find interests in other vocations.
   g. Establish local endowment funds to sponsor teachers in their preparation to teach sciences.
   h. Recognize outstanding teaching with awards from the local endowments. (See Figures 1 and 2.)
   i. Recruit teachers at the undergraduate level. We have become more overt and our current enrollments are 28 biology, 34 chemistry, 10 physics, and 12 earth-space.

5. Contemporary Expertise
   a. Invite all teachers, but especially science teachers to visit the local industries to see first hand modern techniques and equipment.
   b. Invite teachers to the local industry sponsored seminars on technical advances.
   c. Provide teachers the opportunities to work in local industries during the summer for vacation relief.

6. Human and Technological Need
   a. Change current teacher staff development practices toward those used in successful businesses. Naisbitt describes the trend toward that human concern in making technology work efficiently (2). Peters and Waterman elaborate the conditions that have to be met if employees are to be productive over a long period of time (4). The advantage of the industrial model, which has been successfully adapted in the /I/D/E/A/ School Improvement Program developed by the Lilly Endowment and the Charles F. Kettering Foundation (10,11), is that accountability is addressed without sacrificing each person's human needs. A second

advantage is that the public sector, dependent upon taxes for budget, could never provide the sustained effort to the degree necessary to actually bring the understanding into everyday practice. Arthur Anderson, for instance, budgeted 2% of their ($5-10 million) budget for one division just in designing the training and retraining staff development program for one year (12).

7. Standardization of Technology Hardware
   a. Videotape is in the throes of moving from 3/4 inch to 1/2 inch systems, and ultimately will prove to be no problem. The deliberate incompatibility of software and hardware in the microcomputer field make utilization of this technology virtually impossible. The current attrition of companies producing home and business stand alone computers may leave only one set of hardware as the standard, as has taken place in the world of the selectric typewriter and terminal keyboards.
   b. Seek to get hardware such as microcomputers and videodisc and microwave dish equipment to interface easily in school settings.

8. Software
   a. Encourage development of standards for quality computer courseware. Most educational software is poor, but potential developers' intuitive wisdom is insufficient to produce effective instructional impact. Districts should use the EPIE services available through PDE.
   b. Encourage inservice and special workshops to train teachers in the development of courseware. Instructional design is a recently developed technology, and much of the principals' perception of the need for teacher training in instructional technique can probably be attributed to inadequate design skills (7). Proper design built into courseware programs has the propensity for precise correction and tuning of ineffective portions.
   c. Encourage inservice and special workshops to train educators in the techniques of computer based diagnostic testing.
   d. Encourage teachers to use authentic, contemporary data and descriptions of problems and techniques used in industry as the basis for the courseware.
   e. Invite professionals in industry to contribute courseware modules.
   f. Invite industry to sponsor production of high quality videodisc depiction of processes and phenomena that can be accessed by microcomputer. (Note: current NOVA and other television programs are not designed for instruction beyond awareness or tweeking curiosity or learning of unrelated facts. They are not conceptual in design).

9. Funding Changes
   a. Establish non-profit corporations to develop and manage local endowments, the interest from which can stimulate science teacher recruitment, science teacher growth, creation of meaningful student projects, and acquisition of science equipment. The tax sources will not be able to create the funds necessary to reach excellence in education. Excellence comes from pride and self-help, through aspiration raising, and through recognition of productive approaches.

b. The legislature can involve industry in improving science education through tax benefits. Industrial contributions could include donations of slightly obsolete equipment to schools, or voluntary servicing of equipment, of hosting teacher centers, or sponsoring awards and recognitions, or employing teachers as consultants or other forms of science promotion.
c. Similarly, a state and national government can stimulate the use of instructional telecommunications so that students can learn from home, or in neighborhood groups with adults, or in beamed workshops within local industries. Pennorama has high potential.
d. Public and school libraries should seek to acquire media, including floppy diskettes, and the equipment to use the media, to promote independent learning for all socio-economic sectors.
e. Individuals or libraries can promote diskette exchanges (like book or comic book exchanges) to increase the flow of learning options.
f. Private entrepeneurs of instruction should be encouraged. High school youth of today could develop relatively strong businesses by teaching other youth or adults computer techniques.
g. Schools should be eligible to bid on instructional design contracts for the state or industries.

Closing Remarks

Some of the above ideas for solutions have been accomplished by courageous and enterprising persons and groups. The theme is really not one of anti-establishment or deschooling society. The thrust is to circumvent dog-in-the-manger power politics, but not by establishing new power structures. The idea is to encourage creative individuals and groups to help themselves.

There is nothing in Act 195 that precludes local associations from taking leadership in implementing all sorts of resourceful plans -- as long as they don't become the substance of collective bargaining. Similarly, excellence cannot be legislated, but legislative bodies and regulatory agencies can establish mechanisms to inspire creative solutions to educational problems, and establish higher norms of expectation.

We use to take pride in the mom and pop establishments. Now, with the home computer, ubiquitous telephone lines, and microwave dishes that are cheaper than cars, virtually every home can become a mom and pop and kid business promoting education (14). It's the American way.

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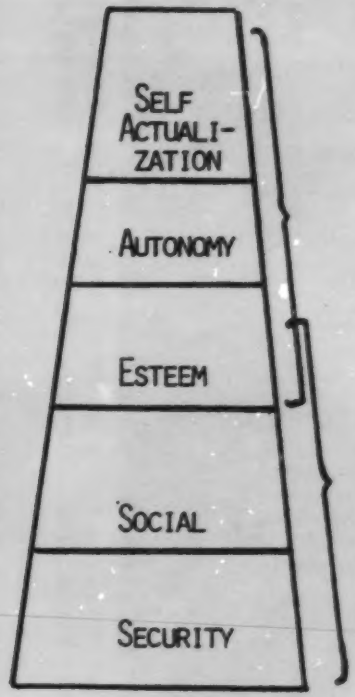
FIGURE 1: MASLOW'S HIERARCHY OF NEEDS



MOTIVATIONAL POTENCY

1. HIGHER-ORDER NEEDS
2. SUPPORT FOR SECOND LEVEL DECISION (PERFORMANCE)
3. TO BE EARNED ON JOB
4. HIGH MOTIVATIONAL POTENTIAL FOR PROFESSIONAL TEACHERS

1. LOWER-ORDER NEEDS
2. SUPPORT FOR FIRST-LEVEL DECISION (PARTICIPATION)
3. CONSIDERED AS JOB GIVENS
4. LOW MOTIVATIONAL POTENTIAL FOR PROFESSIONAL TEACHERS

FIGURE 2: HERZBERG'S MOTIVATION/HYGIENE FACTORS

Job Factors	Percentage of Highs NR = 142	Percentage of Lows NR = 142	P
1. Achievement	30*	9	.01
2. Recognition	28	2	.001
3. Work itself	11	8	
4. Responsibility	7*	1	.05
5. Advancement	0	1	
6. Salary	2	3	
7. Possibility of growth	6	2	
8. Interpersonal relations (subordinates)	7	20*	.01
9. Interpersonal relations (superiors)	3	4	
10. Interpersonal relations (peers)	1	15*	.001
11. Supervision - technical	1	10*	.01
12. School policy and administration	2	13*	.01
13. Working conditions	2	6	
14. Personal life	0	5*	.05
15. Status	0	0	
16. Security	0	1	

N = 72 teachers; NR = number of responses

* Significant factor.

Problems in Science Education

Dr. Margaret Smith
Commissioner of Basic Education
Pennsylvania Department of Education

Good Morning

I'm glad to be here and to be a part of this very important conference on science education. I will present comments from the perspective of my position in the Department of Education, as well as from having been in public education for 19 years.

I will discuss two major concerns in science education, which are both very much interrelated. The first has to do with students and the second with teachers.

Student Problem

We have a serious problem in the number of secondary school students who do not elect to take science courses (#1 refer to statistics). A second student problem is that in many schools the only science courses offered are aimed only at the college bound student and are too rigorous for the average student even if they did elect to take them.

Elementary science programs vary greatly from school to school and from teacher to teacher within a school, with the amount of time devoted to the teaching of science in the elementary schools as well as the content of the science program dependent upon the amount of training of the teacher. Unfortunately, the average elementary teacher has had little exposure to science education and does not feel confident nor comfortable about teaching science as a subject.

Another critical concern with science education for students, is providing equal opportunities for women and minorities in the sciences. The cultural expectation that women and minorities cannot be as successful as white males in the sciences continues to result in few of these individuals entering the science field.

Pennsylvania is one of the 35 states that require students to take only one high school science course to graduate.

Teacher Problems

There is very probable shortage of science teachers in the near future. At this time, we do not have a statewide shortage, but we do have shortages in regions of the state, such as urban areas (ex.-Phila.) and rural areas. The most critical shortage is physics. (#2 - Refer to statistics) In 1981-82, then new certificates were issued to only 24 science teachers in Pennsylvania, while more than that number left the profession. The average age of science teachers in Pennsylvania is 42 years and when these people retire, there will not be enough replacements.

Furthermore, many of the men and women who are teaching science are neither as current nor as knowledgeable in their subjects as they should be. Pennsylvania's science teachers have been teaching, on the average, for 15 years, and most have not taken additional college course work in their subject area for the past 11 years.

What is the Department of Education Doing to Address the Problems of Science Education and What Else is Occurring in Pennsylvania to Address These Concerns?

Since last May there has been a very extensive mathematics/science initiatives task force underway. The task force, comprised of department staff and representatives from school districts, is giving attention to curriculum, staffing, and partnerships with business and industry. The final report should be completed by the first of the year. These recommendations will identify the leadership and assistance role of the Department for science education.

In the Commonwealth's 1983-84 budget, the Governor proposed, and the General Assembly enacted an appropriation of $300,000 to begin finding effective ways to improve mathematics and science programs in public schools. That funding will be used to upgrade the skills of teachers, provide material and other resources for instruction in these subjects, and encourage the development of business and education partnerships to improve school math and science programs. The Department has been charged with implementation and will shortly announce the specifics.

The Pennsylvania Higher Education Assistance Agency (PHEAA) has initiated a Scholars in Education Awards Program which offers tuition assistance to academically strong students who enroll in mathematics and science programs and commit themselves to teach those subjects in Pennsylvania schools. Qualified students are offered up to 50 percent of their tuition per year, which is subtracted from their loan as they fulfill their teaching commitment.

The Commonwealth is also working with its Washington office, to hasten passage of federal legislation which would provide funds to improve mathematics and science programs in Pennsylvania.

Both the proposed State Board of Education Regulations (Chapter 5) and proposed legislation (House Bill 1181) would increase the present science requirement for graduation from one course in grades 10-12 to three courses in grades 9-12. This is an increase of two required courses.

The Governor in his proposed agenda for excellence, "Turning the Tide," has recommended a PA Honors Program which would include (1) a rigorous honors curriculum in high school, including higher level science courses, (2) an honors test at twelfth grade to qualify for an honors diploma with the top 1% of the students in the state to be awarded $1,000 scholarships to be used toward their college education.

Last year was the second year of the Governor's School for Sciences at Carnegie-Mellon University and the hope is to expand the number of students served by that program this coming summer. This program serves the state's most promising future scientists.

I have been informed that the American Chemical Society is in the process of preparing a High School Interdisciplinary Chemistry Course for general students. ACS is commended on this effort which is timely and very much needed.

#1 PA SCIENCE ENROLLMENTS (1981-82)

Biology 151,877
Chemistry . . . . . 67,263 (44% of students who took Biology)
Physics . . . . . 34,359 (51% of students who took Chemistry)

#1 % of 1981-82 GRADUATES WHO TOOK SCIENCE COURSES

	Pennsylvania	National
Biology . . .	99.9%	45%
Chemistry . .	47.0%	17%
Physics . . .	24.0%	10%

#2 SCIENCE TEACHERS PREPARED (1981-82)

1385 Secondary teachers

Total Science 211
Biology 115
Chemistry 34
Earth Science . . . 32
General 27
Physics 3

Physics-Math combination . . . 2

Science Education

The Honorable Jeff Coy
Education Committee
Pennsylvania House of Representatives

I have the sinking feeling that before this session is concluded, you will be hearing any number of repetitious comments. I hope I don't contribute too much to the redundancy.

Perhaps there is one "cop-out" I should make before going any further. I am a stand-in for this performance -- an understudy, if you will. So, if there are any cat calls to be made or any over-ripened fruit to be hurled -- I'll give you the name and address of the star performer and you can deliver those items in his direction. That doesn't mean that I'm speaking off the top of his head or from the depths of his background. I'll take the rap for any missed cues or forgotten lines.

From my personal perspective, it seems there has never been a time when our educational institutions have not confronted one crisis or another. Naturally, each new problem seems more disasterous than the one which preceded. It's difficult today to try and convince anyone that the growing rate of functional illiteracy is not more devastating than the Humanistic doctrines of John Dewey a half-century ago. On a somewhat more contemporary basis -- try to imagine anything that could be more traumatic than the voyage of the Russian space vehicle Sputnik into outer space. The realization that Soviet technology had gone into orbit before we could get there did not come easily. It created severe upheavels in our educational community. Some of the reverberations still exist. That this country was the first to take that historic "giant step" on the lunar surface tended to ease some of the mortification. All in all, however, Sputnik was a rather sobering incident in the annals of American education.

But the problems never cease. I cannot help but agree with the basic premise of this conference -- that there are serious problems confronting the scientific educational community, not only in this State, but in the nation as a whole. I must confess that I feel slightly uncomfortable as a speaker on this subject. I would be more at ease -- and perhaps accomplish more -- as a listener and an observer. And I hope to be able to do that as the day progresses.

If you look at any of the recent national studies on our educational systems -- and it seems as though there has been one almost every month -- they tend to stress the need for more meaningful training in math and the sciences. One of the problems that I face as a Legislator and that school administrators face in their capacities is this: Who will do the training? There is a dearth of qualified math and science teachers. It's been a nagging problem for quite some time.

If you ask the psychologists, they can probably provide any number of reasons for the apparent lack of interest in these fields. In all likelihood they would reiterate some of the comments they've undoubtedly heard, such as: "Who needs to learn about addition and subtraction? A little Texas Instruments will take care of all that." "Why bother about balancing the checkbook? The bank will send out a statement every month. I'll take their word for it." "When it's tax time -- the IRS will figure it out for me." These things have been a source of concern for those of us in the legislative area.

Recently, the Pennsylvania Higher Education Assistance Agency -- better known as PHEAA -- took steps administratively to try and ease that problem. The gentleman for whom I am standing-in today is Chairman of that Agency. The PHEAA Board, 16 of whom are legislators, devised a program to enhance the opportunities for those inclined to pursue a career in math and science teaching. It eases the financial burden of their college training. This same plan also provides for upgrading skills, knowledge, and techniques for those already in the profession. This would be accomplished through in-service programs. Perhaps the real beauty of the PHEAA project is that it doesn't dip into the State coffers. It involves no drain on the General Fund. Not long ago, I voted to concur in the proposed regulation designed to carry this program into operation. One of the responsibilities of the House Education Committee, on which I serve, is to review regulatory proposals of the various educational agencies of State Government.

Funding for the loan and grant aspects of these programs is derived from earnings which PHEAA realizes from contracts to service the loan programs of other states. Last June, Chairman Gallagher turned over to the State Treasurer a check for 19 million dollars. The interest earnings from that money will supply the financial backing.

These programs are called Scholars in Education Awards (SEA) and Science Teacher Education Program (STEP). The loan aspects of the project include a provision that would allow participants to receive one year of loan forgiveness for each year they spend in the classroom teaching math or science. It was initially anticipated that about 50 qualified students would be selected to participate in the current academic year. Although the project got off to something of a late start, a total of 94 applicants were accepted. They are presently enrolled at one of the 68 colleges and universities in Pennsylvania that are qualified by PHEAA to offer the required training.

Meanwhile, back at the ranch the Legislature has been enmeshed in several proposals which impact seriously not only on the quality of education, but on the quantity, as well. Generally speaking, these proposals stem from one or another of the national studies to which I alluded earlier.

One of the first major pieces of legislation taken under consideration by the House Education Committee in this session was designed to stiffen graduation requirements in Math, Science, English and Social Studies. This same measure, which is labeled House Bill 1181, would require student testing in Grades 2, 5 and 8 as a means of identifying needed remedial programs. This remediation is also required in the legislation. Aside from remedial

testing at the earlier grade levels, House Bill 1181 would also require the successful completion of a standardized achievement test in the 11th Grade as a requisite for graduation.

Concurrently, the State Board of Education has been in the process of revising its Curriculum Regulations. That procedure has been underway for more than a year. The protracted nature of the State Board deliberations on the Curriculum had generated considerable speculation that the House Education Committee was trying to pull and end run -- or to usurp the function of the State Board. There were those in high places who were convinced that House Bill 1181 was only a subterfuge -- that we were just kidding. I can assure you, that is not the case. I venture to say that any notions along that line probably went out the window two days ago when the House Education Committee voted unanimously to recommend rejection of the State Board's Curriculum Regulation. That recommendation has been delivered to the Independent Regulatory Review Commission which may -- or may not -- go along with the Committee's position.

Perhaps I should digress for a second to make one small point. In the overall scheme of things, statute takes precedence over regulation. Rule makers do not take authority over lawmakers. The disheartening aspect in all of this -- as far as I'm concerned -- is that the State Board and the House Education Committee are on the same track with regard to bolstering the curriculum, stiffening graduation requirements, and improving the achievement level of less capable students. Actually, the graduation requirements contained in House Bill 1181 are identical to those of the State Board proposal in Math, Science, English and Social Studies. The State Board regulation goes a step further by requiring additional graduation credits in Arts and Humanities, as well as elective courses -- which could include vocational-education programs. We in the House Education Committee do not disagree with this. Actually, I'm almost reluctant to mention the point of departure between the Committee and the Board.

It has to do with Educational Quality Assessment and the 12 Goals of Quality Education, which are inculcated throughout the mandated courses of study. Throughout its lengthy deliberations on the proposed new Curriculum Regulations, the State Board has not addressed the issues of student testing and remediation. Both of these concepts are found in House Bill 1181 -- as I have indicated.

While the State Board and the Education Committee were attempting to get off the collision course with regard to curriculum -- another document was plopped on the table. This belated entry in the Educational Sweepstakes was sired by Governor Thornburgh. It's entitled, "Turning the Tide: An Agenda for Excellence in the Pennsylvania Public Schools." When it first appeared, we thought that "Turning the Tide" was a tribute to Joe Paterno for beating Alabama this year. Further examination, however, shows that "The Tide" is literally awash with proposals similar to those contained in House Bill 1181. The Tide endorses the concepts of student testing and remediation. Equally as important, he places a price tag on implementing these proposals and offers his support in garnering the financial resources to put them in place.

Far be it from me to try and buck "The Tide", but the one element in the Governor's proposal that I find hard to fanthom is the timing. The State Board has been laboring over its proposed Chapter 5 revision for many months. The Education Committee in the House initiated a series of public hearings on House Bill 1181 in July and they continued into September. But, it wasn't until last month that the Governor announced his Agenda for Excellence. Instead of bridging the gap that appeared to be widening between the State Board and the Committee, his proposal probably did as much to inject another diversion.

I hope you don't think that what I'm saying is something of a littany of disgruntled partisan ramblings. Actually, I copied this from the comments of one of my colleagues on the other side of the aisle. Strangely enough, her remarks were delivered into the ear of the Secretary of Education.

I'm afraid it might be difficult at this point to try and convince you that the legislative outlook for education is anything but glum. There are any number of analogies that I could make to prove that all is not lost -- but they contain a great deal of banalities and cliches. I do feel, however, that there is a very strong undercurrent of determination and dedication to the objective of improving the quality of our schools and the young people who emerge from them. As a Legislator I am not unmindful of the fact that our State Constitution imposes on the General Assembly the burden of providing for the maintenance of a thorough and efficient system of public education. And, believe me, we need all the help we can get.

Some of that help lately has been coming from sources outside of Government and outside of our school system, per se. More specifically, that support derives from the business community. And it is not solely in the form of financial support. Typical of the sort of arrangements to which I am referring are those outlined by the Task Force on Education for Economic Growth of the Education Commission of the States. It is not a group comprised solely of persons from the governmental and educational communities, but includes representatives from some of the foremost corporate entities in the country.

The partnership envisioned by the ECS Task Force doesn't simply refer to scientific and engineering firms providing a speaker for a PTA luncheon -- or inviting a group of First Graders to tour the company facilities. These cooperative ventures between schools and businesses have a much broader objective; a much deeper perspective. There is no way to deny the obvious fact that successful business people and organizations are keenly aware of the skills required in the workplace. It would make little sense to expect that students are the only ones who might benefit from these partnerships. Teacher training based on the latest equipment and techniques is equally vital and could be available through outside agencies. And, of course, there is management and financial expertise that could be available to superintendents and other administrators through these relationships. Some of these school-business relationships have begun to develop in Pennsylvania. Other states, it appears, have courted industrial support for their educational institutions with something of a passion.

Like most other established institutions, the educational community is not always comfortable with the novel and the unique. First steps, as with children, are often the most difficult. And it is not always the educator himself who develops apprehensions over some of these partnerships with non-school entities. Public indifference -- or outright opposition -- is a factor to be reckoned with. This has cropped up in some instances where school officials have attempted to utilize the help and support of long-established firms and utilities. There are those who resist the notion of commercial policy becoming educational policy.

As shortsighted as these public sentiments might seem, it is incumbent upon the educational leaders to sift out these situations and exercise the critical judgements that will stimulate the available mutual benefits of these school/business partnerships.

Thank you very much.

Science Education Is It Ill?

Larry Wm. Graham
Process Engineer
Appleton Papers Inc.

SYMPTOMS

As an educator, scientist, or legislator, it would be very difficult, if not impossible, to ignore the recent influx of printed material that describes the sickness currently infecting the scientific-educational community. Yes, as the report of the National Commission on Excellence in Education implies we are "A Nation At Risk".

I contend, nonetheless, that the infection is neither disabling nor terminal in nature when detected in its early stages and properly treated. It is, in fact, the United States scientific community that continues to lead the free world in technological achievement and potential. It was an American sweep of the science prizes for 1983 by Nobel Laureates Chandrasekhar, Fowler, McClintock, and Taube. A recent survey conducted for the National Science Foundation by the American Council on Education asked graduate deans to rate the five-year change in applicant quality. Sixty percent reported "no change" while twenty-eight percent reported a "significant improvement".

I have had the opportunity over the past two and a half years to be involved in several talent searches for laboratory technicians and engineers for employment within our corporation. There are quality people out there and I suggest they are a product of this very system we have under the microscope.

No, I do not deny or wish to deemphasize the seriousness of the problem. The uninterrupted decline in Scholastic Aptitude Test (S.A.T.) scores since 1963, along with numerous other similar declines in standardized achievement tests are surely cause for concern. I simply wish to place the problem into its proper perspective and to approach it in a positive posture.

DIAGNOSIS

Suppose we were to examine the problem using a system concept approach. One might consider the pre-schooler as the raw material entering the process at one end, passing through several stages (i.e. elementary, junior or middle high school, senior high school, university) wherein the key ingredients must be properly added by the

science educator. If all goes well, a scientifically literate member of society exits the process at the other end. Be he or she scientist or not, the graduate must be capable of dealing with the science and technology of the twenty-first century or future shock is bound to occur.

Certainly the plight of the science teacher in this process is in many respects a mirror reflection of the problems faced by educators as a whole. Poor salaries, reduced expenditures for equipment and instructional materials, lack of respect from the student, parent, administrator, and/or community - be it real or imagined, lack of preparation time, burnout, and so on. The middle school and elementary teachers are, in many cases, inadequately prepared to present lessons that show the excitement of doing science. Feeling uneasy, this teacher looks to the textbook as a guide. Unfortunately, in most cases the text is more poorly prepared than the teacher in the first place.

Why are science teachers defecting from their positions at a rate of five per every retiree? An average salary of $20,531 for the classroom teacher versus $30,000 for the chemist with a B.S. degree goes a long way in answering that question. Especially when advanced degree salaries and salary ceilings are compared for the private sector versus education. Why were only 34 secondary teachers prepared in 1981-82 with certification in chemistry compared to more than 150 just ten years ago? $13,358 and $20,000, respectively, as average starting salaries for 1982-83 teachers and B.S. nonacademic chemists with no experience is the answer. Furthermore, within certain specialized areas of the private sector like the oil industry, this starting salary discrepancy can be much greater.

Couple all this with the reductions in curricula for science and mathematics requirements over the same time period and the results are not too unexpected.

TREATMENT

There is no question that the solutions to these problems will require a cooperative effort. Neither industry, education, government, or for that matter, society in general can ill afford to sit back and wait for the symptoms to pass. ACTION must be taken, and taken now. I would like to examine some possibilities for this action.

From the federal government, a strengthening of the programs designed to assist the science teacher must be forthcoming. Perhaps the best suited vehicle to accomplish this goal is the National Science Foundation. House bill 1310 and Senate bill 1285 are good starting points for such programs both within the Department of Education and NSF. The $425 million for fiscal 1984 and $540 million in 1985 called for by this legislation will hopefully be signed into law soon.

Cochairpersons Coleman and Selby of the National Science Board commission have already introduced the NSF plan for improving science education over the next eleven years. The plan may be somewhat ambitious with its first year price tag of $1.51 billion, but it certainly strives to return the NSF to the position of strength it enjoyed in the post Sputnik years.

One might even be tempted to fantasize a bit about the federal government's role in treating this problem. Perhaps the I.R.S. would help. Tax breaks for teachers, incentives to industry that encourage the donation of used equipment to public school systems, or whatever it takes to get the job done, but the spending power of the teacher must be brought up to professional standards.

And what do we ask of the Commonwealth of Pennsylvania? I propose a stepwise increase in the level of state revenue towards public education from its current estimated 45.15% to 50%, be it constitutionally required or not.

The educational system itself holds a great many of the keys necessary to determine its own fate. It is absolutely essential that standards which will support a sound understanding of both scientific principles and an appreciation of what it is that scientist do, be established. These standards should be agreed upon by all concerned - administrator, teacher, student, and parent. Once implemented there should be no excuse not to adhere. The classroom teacher has got to feel he will be supported when students fail to meet these standards. Furthermore, the standards should require an increased emphasis upon science and mathematics, from college graduate right down to elementary student. A minimum of thirty minutes of science per day and one hour of mathematics per day at the elementary level should be required. The number of science and mathematics courses required for high school graduation should be increased or held at two years of science and three years of mathematics.

If "few in numbers" is to be a way of life for the high school chemistry teacher, techniques that relieve uncomfortable student to teacher ratios ought to be employed. Television programs such as Cosmos, Nova, and 3-2-1 Contact present a genuine opportunity for the student that the classroom teacher cannot, in most cases, provide. Use of these type programs then frees the teacher for other tasks. Certainly the computer, with all its potential, will find itself playing a major role. From simple problem solving to complex laboratory simulations, computer applications not only stir interest but provide time and economical rewards as well. Interdisciplinary approaches to the teaching of science would assist in providing the student with an appreciation of the essence of science. The English teacher who deals with the works of an Asimov or Sagan, or the mathematics teacher who uses solution concentration problems to do percents can do the science teacher a great service. Local school districts should consider the need for a dozen or so administrative assistants or a science coordinator.

Funding alone will not cure this illness. Everyone involved must be held accountable. Time and effort will have to be spent to structure programs that will meet the needs of society.

The private sector stands in a position of being able to provide a great many resources. The National Geographic specials, Walt Disney productions, and others are examples of the type of high quality support industry can and should provide more of. Time is an expensive commodity in the profit oriented business world. I feel strongly, however, about the positive things that come from a chemist or engineer taking that time to go into the classroom and relate to a group of students what it is about his work that makes each day exciting. A speakers bureau, consisting of community people from the private sector, can offer a variety of scientific experiences not available to the classroom teacher.

Co-operative work programs have been documented as being successful at the collegiate level. Why not extend modifications of these co-op programs to include high school students interested in science? In fact, a co-op program designed for the science teacher not only offers summer employment to the educator but also a learning experience to be used later in the classroom.

Without question, a closer relationship between the private sector and the science educator would be mutually beneficial. An organization like the American Chemical Society is well suited for playing a leading role in that relationship. Its membership represents a cross-section of the scientific community from high school teacher to research directors. An effort to expand that membership, especially into the ranks of the high school chemistry teacher, should be encouraged.

These are but a few ideas that might help in the disinfection of this problem within science education.

PROGNOSIS

Allow me to conclude on the same positive note I began. I have a great deal of confidence in our educational system in general and specifically in the community of science educators.

The renewed commitment brought about as a result of "A Nation At Risk" is a welcomed light at the end of the tunnel. The time for dialogue has come to an end and the time for action is upon us. I challenge all associated and concerned parties to develop an action plan to meet the goals of improved science and mathematics education and to implement that plan today. Given such an effort, recovery is inevitable.

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Panel Discussion

Dr. John H. Grezlak, Editor

The Status of Education

Since the math and science boom of the 1960's, math and science education in the United States has been on the decline. During this time concern in this area has fostered numerous conferences, studies and discussions on the problems in education as well as the educational reforms necessary to effect solutions. Yet it wasn't until the issuance of the recent and condemning report A Nation At Risk, which had been built upon these earlier investigations, that the problems in math and science education achieved national, state and local attention.

The indicators of this decline are clear and numerous. They extend beyond the often quoted decline in SAT scores. One-third of all high schools in the United States offer no calculus. 30% of all physics courses are taught by unqualified instructors. In 1982 the average starting salary for a teacher was less than $13,000; starting salaries for engineers at the same educational level was $22,568. Thirty-six states require only one year of science in the high school. Thirty-five require only one year of math. In 1980 only 38 chemistry and physics teachers were graduated in the state of Pennsylvania. In our state the average age of a math and science teacher is nine years higher than the average teacher; we are losing the new knowledge and innovations that young teachers can bring into the profession. The list goees on.

Moreover, the problems are not restricted to math and science education. They extend into the entire realm of education. It has been reported that our current education majors and future teachers have SAT scores 80 points below the national average, that 50% of class time is not involved with instruction and is wasted and that the average high school student in Japan, our major competitor, undergoes six more years of education than the average high school student in Pennsylvania. Here again the list does not stop.

This conference, however, was not held to elaborate the manifestations of the decline of our educational system in general nor in math and science in particular. Rather it was held to contribute to reversing this trend by identifying and/or confirming some of the causes and by suggesting and, if possible, effecting solutions.

Student Attitudes

Most studies into the causes for and solutions to the observed general decline in education have concentrated on nonstudent populations and their responsibilities: lack of government funding, poor teacher preparation and professional development, lack of administrative training and support, etc. However,ultimately this general decline in student learning and performance rests with the student him/herself. Student

attitudes, in fact, play a major role in the success or failure of any educational system. Model studies in Chicago have shown that highly motivated students can achieve substantially high goals in spite of lack of funding and poor facilities.

Unfortunately, high motivation in students need not be the norm. Second grade teachers currently report that it is difficult to overcome current student attitudes. The work ethic has disappeared; students simply do not see the value in working and learning. Free public education is not cherished the way it once was.

Equally unfortunate, these attitudes are not restricted to the second grade. When asked to choose between high school courses, too many students shy away from the more difficult courses in math and science in favor of courses in courtship and marriage. College faculty are increasingly seeing students who not only select the " easy B " general elective course but also decline to put maximum effort into their major courses. Employers are finding more college graduates who possess poor work habits and lack the work ethic.

Certainly, much more research must be done in this area but one current thought about the cause of this problem is that student role models changed in the 1960's. Children no longer developed the work ethic at home or on the farm. The 1960's gave us a time when increases in the standard of living and leisure time depended less on productivity and more on a booming economy, strong unions and short-sighted management. The resulting poor work habits have trickled both up and down the ladder.

To turn this around, students must again be placed in a work environment at an early age just to find out what to do, what is required, that work will sometimes be boring and that work and achievement correlate.

House Bill 1181 will be a positive step in this direction and calls for testing of students at the second, fifth and eigth grade levels. Students will be forced to realize that they too have an interest in the educational process and that they will have to work to achieve and succeed.

All will have to support these efforts. Teachers will have to assign more homework, challenge the students with higher goals and demand performance by eliminating social promotions and reducing grade inflation. As they cannot accomplish this alone, they will need the support of the school administration, the school board, parents and the community. As was pointed out, at least one community in Pennsylvania sends its entire senior class to college every year.

Quality Control

Corporations like the Piggly-Wiggly Company, Delta Airlines, and Datsun maintain quality through the use of quality circles and attribute much of their success to these circles. Periodically, management and employees meet to discuss manufacturing problems, etc. and to jointly effect solutions. In effect, the people who experience the problems first-hand play an active role in solving these problems. Productivity increases not only because the joint solutions are more valid but also because

of the increase in employee morale.

This raises the question as to whether or not such an approach might work in the school. Currently, teachers face problems every day which can inhibit quality. Yet they are far removed from the people who have the power to make decisions and thus solve these problems i.e. the top administrators and school board members. All too often these people have not been in a classroom since they graduated and lack a firm understanding of the problems however well intentioned. Conversely, teachers are often unaware of the problems and the limitations that face the administration. Quality circles would allow for more effective communication and more valid solutions to existing problems. As with industry productivity and morale should increase.

The panel agreed, however, that quality circles have not worked in the majority of cases. They start out with great promise but fail as management defensively guards its perogatives. As a result productivity and morale drop further with the increasing disappointment.

An alternative approach to quality and morale utilized by many successful industries is simply that managers manage. Managers must admit that if there is a quality or morale problem, it is the fault of management. Since they are the decision makers, they must find out what must be done and they must do it. They must have the attitude that everyone, management and employees, make mistakes and no one will be fired for these mistakes. However, all must grow from these mistakes and all must improve. By analogy if there's a problem in morale and quality in the schools, it is the fault of the administrators and the school board. It is their responsibility to solve these problems and to see that all constituents learn and grow.

Quality circles can, nevertheless, succeed in schools provided that administrators and school board members receive better training from higher education. They need to be concerned not only with the decision-making process but also with the decision acceptors. They must be trained in the techniques of organizational communication and to recognize the importance of high participation rates in the decision-making process and its relationship to the ability to get things done and to morale in the organizational climate. They must receive this training and have the ability, understanding and ego strength to function in that kind of climate if quality circles are to work. Higher education must accept a greater responsibility in providing this training.

Attracting Quality Students To Teaching

A major problem in math and science education is one of teacher supply and demand. Demand is currently high and expected to increase with new curriculum requirements. Conversely, the supply of quality math and science teachers being graduated from college remains low. We all must contribute to attracting quality students into this profession as we all have a stake in the outcome. For industry it is a quality insurance policy. For college it will mean better students in both the short and long run. For the commonwealth and the nation it will mean a better

educated workforce and a better economy.

Government has already taken some major steps in this area through PHEAA's Scholarships in Education program. Scholarships are being awarded to students and prospective teachers with the following stipulations:

1. Students must have (a) combined SAT's >1000, (b) a math SAT >500, (c) a class ranking in the upper 1/5, (d) a 3.0 in math and science courses and (e) the recommendation of a math and science teacher.

2. Students must agree to teach in Pennsylvania upon graduation.

Teachers can also contribute in this recruitment. In spite of less than desirable working conditions, inadequate salaries and a respect that all too often is only high during conferences such as this, you love this profession and the good that it does. You still find excitement in your discipline. Show these feelings. Assist and encourage your students who are considering teaching as a profession. Show them what the entire profession is about, both benefits and detriments. Make them aware and then let them decide.

Administrators can also support these efforts. Much of the love for and understanding of science is developed in the elementary school experience. Here too is developed the fear and mistrust of science. If we hope to educate more scientists, more science teachers and a more scientifically literate populace, our efforts must begin here. Increase the emphasis on science in the classroom. Assist the teacher by providing the professional development opportunities necessary. Parents, local high schools and colleges can be helpful in these efforts.

A second way that administrators can contribute to attracting students to teaching is to provide funds for student assistantships. Student assistants would be able to learn about the profession by assisting the teacher in preparing laboratories, tutoring students, monitoring laboratories, etc. This would not only increase student awareness of the profession but also ease the workload on the teacher and increase safety in the laboratory. The utilization of a financial award would reward the good student, increase his/her incentive and eliminate competition from external work opportunities.

Higher education must raise admission and graduation requirements. In the past higher education erred in emphasizing education courses at the expense of courses in the discipline. Surveys have shown that this discourages the good student who is interested in chemistry from pursuing this interest through the B.S. Ed. route. Secondly, it tended to produce teachers who knew how to teach but who lacked significant knowledge in the discipline they were supposed to teach. As there is currently a high degree of variability between the education programs in the Commonwealth of Pennsylvania, to some extent this problem still exists. In some schools in Pennsylvania the total number of nonmajor chemistry courses and/or major chemistry courses that are required for the B.S. Ed. in Chemistry is not as great as the number of chemistry courses required for a minor in chemistry in

other schools. To ensure the production of quality teachers, higher education should raise the standards necessary for admission into the B.S. Ed., raise the grade point average necessary for graduation and increase the number courses in the major discipline at the expense of minor courses and education courses- for majors in chemistry the number as well as the content of these courses should meet or exceed ACS guidelines. The primary path to achieving knowledge in a discipline should be through college coursework in that discipline. Educational techniques and methods might best be learned through in-service seminars, workshops, etc.

Even with these efforts there will be limitations to the success achieved as both the economy and the state of the teaching profession manifest their roles in the selection process. U.S. Steel recently closed a research laboratory with the loss of 120 scientists. When the economy is ill and industry does not hire scientists, students in turn will not major in this area. Since many science teachers originally enter college as science majors but eventually switch majors, less science teachers are also produced. Until the U.S. incorporates the technology which it developed and the Japanese use, manufacturing will face hard times and so will science education.

Lastly, there are many problems in the teaching profession. As we encourage students to enter this field by expounding its virtues, we are also under a moral obligation to divulge its problems. According to a recent survey of college chemistry majors, the three most important factors in choosing science over science education in order of importance are (1) work duties, (2) salaries and (3) prestige. Until the problems associated with these factors are solved or reduced, attracting quality students to teaching will remain a problem.

Maintaining and Improving Quality in Teachers

As in any discipline there are many excellent teachers (as was obvious by the presence of many ACS award winners and nominees) and many not so excellent teachers. In any discipline you will find people with a spectrum of abilities, and it both naive and unrealistic to expect or assume otherwise. The key to maintaining and improving quality, therefore, is a professional development program designed to optimize these abilities. Here again school districts should consider a common program employed by both industry and higher education.

Drawing analogies, the development program for a new teacher should consist of a long induction period, three to five years of intensive interaction among the new teacher, his/her peers and the administration. The period should be one of intensive learning and development. It is unrealistic to assume that the new teacher has already maximized his/her abilities or that an accurate assessment of these abilities can be made in one or two years. It is also unfair to the new teacher to simply give him/her a key and say go to it only to return in one year to tell him/her what a lousy job he/she is doing. Once the induction period is over the professional development program may be less intensive but still ongoing and active.

The entire professional development program should consist of review, evaluation and development, which is more frequent during the induction period. At specific times the new or tenured teacher would sit down with peers and administrators and mutually identify strengths and weaknesses - strengths to share and fully utilize and weaknesses upon which to build. Both parties would then mutually define and agree to realistic objectives designed in improve both strengths and weaknesses. Finally, the administrative and peer support necessary to achieve these objectives would be mutually agreed upon and provided.

Critical to the success or failure of such a program is achieving a state of mutual trust, the most difficult hurdle to overcome. Administrators must be willing to accept a sharing of some administrative perogatives and a sharing in the decisions and truly mean it. As characterized by a few federal administrations, all too often this sharing is mere lip treatment. Commissions are created with the expressed purpose of supporting the administration where results are utilized if compatible with the administration's viewpoint and discarded or ignored if otherwise. They must be willing to make the commitment that no one will be fired or layed off but that all must continue to grow. They must provide the financial and moral support necessary for growth. They must be honest and consistent. They themselves must be willing to grow.

Teachers and their unions must do likewise. They must become more professional and police their own membership. They must establish their own standards and discipline their own people. They must be willing to challenge the slaggards that hurt the profession. They must be willing to accept retraining as an alternative to layoffs. They must be willing to share in the bad times as well as the good times. All this may be difficult. It may take time accompanied by growing pains. However, it can be done; it has been done.

Also obviously critical is the availability of professional development programs. The following were suggested:

1. In-service training
2. Industry-high school-college partnerships similar to the Ben Franklin Partnership
3. Summer employment and enrichment opportunities in industry
4. Summer employment and enrichment opportunities in academe
    a. Employing teachers in summer programs
    b. Summer institutes for improving knowledge in a discipline or in educational techniques and methods

Unfortunately but realistically, all these activities will take money. Because of their stake in basic education, both industry and higher education are encouraged to contribute. It is unrealistic and unfair, however, to expect too much from these institutions. Each has its own function and responsibilities. The contributions that higher education can make are further limited by its own dire economic state. It is also unfair to assume that teachers with their limited salaries can carry the full burden of the cost of professional development activities. Ultimately, the burden rests with the community, the local, state and federal governments.

Keeping Quality Teachers

If all math and science teachers who have graduated or will graduate were to stay in the teaching profession, the current and increasing shortages would not be as severe. Unfortunately, many are leaving. In 1983 one-third of the newly employed math and science teachers in the state of New York left the profession. Similar statistics for the past few years have also been reported for Pennsylvania.

Although many problems must be addressed in order to halt this defection, all conferees agreed that teacher salaries must be increased - without question. The manner of this increase, however, was debated.

The essence of one approach is based on the underlying economic principles of supply and demand. First of all, society determines the value of people and things, based on a system of perceived immediate needs. For example, microcomputers are instuments of great utility; the computer engineer who designs them is highly valued. As we need medicines for better health, the chemist who synthesizes them is also highly valued. Education, however, does not yield a firm product that is easily perceived to satisfy an immediate need. Ergo, teachers are not as valuable as engineers or scientists. Only in the unlikely event that value systems change will salaries for educators significantly improve.

Secondly, within this system relative values will fluctuate with supply and demand. Thus, as the demand for math and science teachers currently exceeds supply, school districts will simply have to pay more for these people - much more than other teachers but, as previously implied, not as high as scientists, engineers or other members of the scientific community.

This viewpoint was debated by conferees who refused to equate the world with industry and to characterize society's entire value system as a mere reflection of the laws of supply and demand. Education does not make a product which it sells to the highest bidder. It produces the educated individual, an investment for the future. Just what price tag should we attach to a future President, a future Nobel prize winner or simply a future productive member of society? Exactly what price tag should we attach to the future? If we truly value our society today and look for a better tomorrow, should we not also value the teacher which manufactures that product which will be tomorrow?

We live in a northern industrialized state which is seeking manpower for a technological reorganization. Yet our state sends only 38% of its high school graduates on to college, the lowest in the nation. We are and will continue to be part of a scientific and technological society. Yet our nation's educational system is producing less scientists both in quality and quantity. It is producing future government and business leaders who must make decisions affecting science and technology who are illiterate in this area. We are in danger of losing our leadership in this area and becoming a second class nation whose economy is dependent on others. What value should we place on the

manufacturers of the scientists and leaders who can reverse these trends?

The construction of an educated individual involves the input from teachers of many disciplines. Of what value is the scientist who cannot communicate his/her ideas, who cannot understand people nor the impact that these ideas may have on society and who creates a useless product? The useful scientist is a composite of all disciplines as is the politician, the businessman, the farmer, etc. The English teacher and the history teacher are just as valuable as a science teacher. Salaries for teachers must be raised across the board. When a local school district hires five new teachers at the same starting salary as a new school janitor, something is wrong! When serious proposals are presented that would mandate a minimum starting teacher's salary that is equal to the current average starting salary and $500 greater than the aforementioned janitor, something is wrong!

Recommending an across the board increase is not to say that we cannot also have a salary system that promotes and rewards excellence in teaching. We can still have a differential salary schedule based on excellence in all disciplines and not between disciplines. Universities have been successfully using such a system based on peer review for years. Local school districts and teachers unions should explore this model.

The conferees did not discuss just how to go about funding these increases. Two participants did suggest that the reason for this is that we do not know how or rather that the people who can were not at the conference. The answer itself is obvious. If basic education is funded by local and state revenues, local and state governments will have to increase these revenues. This answer is probably quite unpleasant to the office holder for obvious reasons. In the past we have had leaders who led rather than followed. In the past we have had leaders who had the courage to pursue the right course in spite of the political risks. Hopefully, these people exist today and will act.

Improved salaries alone, however, will not keep the quality math and science teacher from leaving nor will it alone attract new ones. Working conditions must also improve. Teachers must first be allowed to teach. They must be given adequate lab time and preparation time and not be burdened with guard duty, disciplinary duty or meaningless paperwork. As a surgeon needs adequate facilities to perform his/her function, so does the science teacher. Science can not be taught without chemicals in outdated and dangerously overcrowded labs with outdated and broken equipment. Unless working conditions improve, quality people are not going to enter the profession, nor will they produce, and nor will they stay. We encourage administrators, school board members and parents to personally investigate the conditions and to work with the teachers to improve these conditions.

The Future

We have much to be proud of in our educational system. Unlike other systems it instills individuality and originality. It has produced world leaders and Nobel laureates. It has made us

a world power and has given us a high standard of living. In many areas of our nation it continues to provide the best education in the world.

However, in spite of internal concern and because of external neglect, problems have developed and grown over the past two decades to a point where they have severely weakened the foundations of our educational system and are threatening the economic and social future of our nation. If our society is not to crumble like past great civilizations, we must learn from history, solve these problems and reverse this decline.

The problems are many; they will not fall to one solution. To those who believe they can be solved by pouring in money alone, this will not change student attitudes. It will not raise standards and expectations. To those that believe that everything can be solved without money, try to realize that to simply maintain an educational program requires yearly inflationary increases. Education is not immuned to that factor which makes the car as well as the computer scientist more expensive than they were a year ago. Try to realize that the same factor which increases the cost of a higher quality automobile or a medical specialist also greatly influences quality in education.

For the most part our solutions have thus far been words as indeed has this conference itself. Now is the time to stop talking. We have seen some movement with the PHEAA program, House Bill 1181 and the new curriculum requirements proposed by the Department of Education. We have learned that the State Senate is considering bills to increase funding for computers and scientific equipment, to establish a mandated minimum salary for starting teachers, and to give corporate tax credits for the donation of computers and scientific equipment, for industrial employees who assist in the classroom and for the use of industrial facilities for instruction. Now is the time for this movement to increase.

To the teacher, much of the future will depend on you. We encourage you to get together with one another to support each other and share your knowledge. We encourage you to increase your professional development activities. We urge you to get out to the people who can do things. For those of you who can make the sacrifice, we encourage you to become active in the community and in the government and to seek decision making positions in these areas.

To all who have participated in this conference or have read its proceedings, we ask you to consider its content, to select one course of action and to act. We and society have all benefited from the education that we had received in the past. We have an obligation to ensure that our children receive the same if not better benefits.

Appendix I

Problems in Science Education - Proposed Solutions

I. Primary problem 1: Shortages of qualified teachers through defection, low college education enrollments or the absence of professional development activities.
   A. Subproblem 1: Large salary differentials between teaching and industry
      1. Overall salary increases e.g. 20% over inflation over a three year period
      2. Merit pay
      3. Longer academic years with prorated salaries
      4. Summer employment in industry
      5. Initial employment at higher steps in critical areas
      6. State mandated minimum salaries comparable to industrial salaries
      7. 100% State funding through increases in income tax with reduction in local property taxes
   B. Subproblem 2: Low prestige, lack of respect, disciplinary problems in classroom
      1. Stronger disciplinary actions
         a. Special classes or schools for disruptive children
         b. Financial penalties to parents of disruptive children
      2. Higher high school and college graduation requirements
      3. Increased community involvement
      4. Professional Development activities
   C. Subproblem 3: Low qualifications of teachers
      1. ACS membership and activities
         a. ACS local, regional and national meetings
         b. ACS short courses and audio programs
      2. Continuing education courses
      3. Undergraduate refresher courses
      4. Graduate courses
      5. Inservice workshops
      6. Higher graduation requirments for education majors
      7. 5 year review and testing of teachers
      8. Cessation of emergency certificates
      9. Employment of retired teachers and scientists to assist
      10. College education curricula involving less education courses and more courses in the discipline or a five year curriculum with the fifth year consisting of education and professional courses
      11. Tuition remission efforts
      12. A high school Teacher Excellence Fund to finance Professional Development efforts
      13. A high school Cadet Teacher Program to recruit prospective teachers from the upper fifth of a high school class
      14. A National Teacher Service program funded with federal resources
      15. A state or locally funded two week Teacher Professional Development term added to the school year
      16. A district sponsored Teacher Travel Fund
      17. School funded Summer Study terms and year long sabbaticals for high school teachers
      18. Competency exams for entering teachers and 5 year peer evaluations

D. Lack of Support
   1. Equipment
      a. Increased taxes
      b. Government grants
      c. College/high school sharing e.g. adopt-a-school program
      d. Industry/high school sharing e.g. I.D.1.c.
      e. Establishment of a centralized "science high school" for S.E. PA
   2. Non material support
      a. From Industry
         (1) Volunteer tutoring and counseling
         (2) Enrichment programs for gifted students
         (3) Industry sponsored awards for teachers and students
         (4) Sabbatical opportunities for teachers
      b. From Principals and Supervisors
         (1) Higher standards and requirements e.g. principals should be licensed teachers and undergo an internship period
         (2) A government/industry sponsored Academy for Principals
         (3) ACS workshops for administrators and other interactions
      c. From Communities
         (1) PTA/Lobbying: awareness efforts
         (2) Parent-teacher-student Advisory Councils
         (3) Parent Volunteer Councils
         (4) Community Coalitions
E. Repetition, Boredom and "Mickey Mouse"
   1. PD activities as in I.C.
   2. Increased responsibilities in text selection and curriculum and course design
   3. Teaching loads of 4 regular sessions plus 1 for seminars and special projects and 1 for class preparation
   4. Exemption from nonteaching assignments like hall and lunchroom monitoring
   5. More flexible class times for laboratories, etc.

II. Primary problem 2: Weak high school curricula and standards
   A. Increased State and local graduation requirements
      1. The NCEE single core program
      2. Proficiency exams with pre-high-school remediation programs
      3. Writing courses limited to 20 students
      4. Senior independent projects
      5. A community service requirement
      6. Minimum homework requirements
   B. Increased college entrance requirements

Appendix II

Task Force for the Study of Chemistry Education in the U.S.

Brief Report

ROUNDTABLE DISCUSSION OF PRELIMINARY RECOMMENDATIONS

29 August 1983
Ambassador Room
Shoreham Hotel
Washington, D.C.

Schedule

8:45 - 9:00 AM	Introduction, Dr. Peter E. Yankwich
9:00 - 10:00 AM	Chemistry for Non-Chemist Professionals (Panel B) Dr. David K. Lavallee
10:00 - 11:00 AM	Chemistry for Citizens (Panel A) Dr. Truman A. Schwartz
11:00 - 12:00 Noon	Chemistry for Chemists (Panel C) Dr. William Eberhardt

Task Force Membership

Panel A Chemistry for Citizens	Panel B Chemistry for Non-Chemist Professionals	Panel C Chemistry for Chemists
Truman A. Schwartz, Ch.	David K. Lavallee, Ch.	William H. Eberhardt, Ch.
Norman Hackerman	Jerry A. Bell	Joseph T. Arrigo
Janet A. Harris	Newman N. Bortnick	William J. Bailey
Donald E. Jones	Harry Hajian, Jr.	O. Theodor Benfey
Stanley Kirschner	Ethel L. Schultz	W. Lincoln Hawkins
William T. Mooney, Jr.	Bassam Z. Shakhashiri	W. Thomas Lippincott
Pauline Newman		Richard W. Ramette
Glenn T. Seaborg		

PANEL A: CHEMICAL EDUCATION FOR THE GENERAL PUBLIC

Panel A has considered chemical education for the great majority of Americans who do not follow careers in chemistry or a scientifically-related field. Members of the panel have generated over 100 recommendations, a number of which are consolidated and summarized below.

A. Public Understanding of Science (Chemistry)

Efforts to improve the scientific literacy of the public require a coordinated pan-scientific approach; therefore we recommend that the ACS assume leadership in convening a conference to explore the creation of a National Commission on Education in Science and Technology, with a subcommission charged with promoting the public understanding of science and technology. These bodies would conduct research, carry out surveys, evaluate progress, organize conferences and workshops, coordinate activities, and disseminate information. The ACS should make more instructional use of radio, explore the feasibility of creating a monthly TV series, and encourage more coverage of chemistry in the popular media.

B. Elementary School Science (Chemistry)

To better prepare all students for life in an increasingly complex society the amount of time devoted to science should be increased. Science should be given the status of a basic area of study and routinely assessed as such. The ACS should provide curricular assistance and support the following: an increase in the amount of science required for teacher certification, the use of science specialists as appropriate, summer and inservice science training for teachers, educational and financial incentives for persons certifying as science teachers, increases in salaries, and efforts to improve teaching conditions and enhance the professional status of teachers.

C. Secondary School Chemistry

Many recommendations regarding the status and preparation of elementary school science teachers also apply to high school chemistry teachers. We advocate inducements to attract qualified people (including early retirees from industry) into the profession, increased salaries and improved working conditions to keep them there, and merit pay and teaching awards to reward superior performance. Industry should help by endowing chairs of chemistry, donating chemicals, equipment and services, and providing summer jobs for teachers. The federal government should fund workshops and short courses, especially those dealing with chemistry for the general student. Such courses should be intellectually challenging and laboratory-based, but aimed at preparing the student for today's technical environment. High school graduation requirements should include three years of science, with a substantial chemical component.

D. Tertiary Level Chemistry

We urge the establishment of significant science requirements for admission to and graduation from college. Introductory and advanced chemistry courses (with laboratory) for nonscience majors should be developed through fellowships, workshops, and information exchange. Experienced teachers should be encouraged to teach such courses and a national award should recognize outstanding contributions. Special courses should be designed to supplement education in law, business, theology and other professions. Collaboration between teachers of chemistry, the humanities, and the social sciences should be promoted with interdisciplinary workshops, short courses, fellowships, and grants for curricular development. A Task Force on Chemical Education for Nonscientists should be established in DIVCHED to coordinate and oversee the implementation of these recommendations.

E. Industrial Interaction with Chemical Education

In addition to the activities identified above, chemical industry should increase public support for science education through interaction with lawmakers, school boards and PTA's, promote chemistry through public media and advertising, and cooperate with educational institutions in curriculum planning.

F. Research, Technology and Science Education

The panel recommends continued federal support for research in cognitive science and information technology and for the applications of this research to science education.

PANEL B: CHEMICAL EDUCATION FOR OTHER SCIENCES AND TECHNOLOGIES

I. Pre-High School Education

Students must be exposed to more and better science before high school. Emphasis should be placed on careful observation and the role of science in everyday life. A severe problem is the inadequate preparation of teachers and a poor attitude of teachers toward science and toward chemistry in particular.

a. As an immediate response to these problems, we recommend the establishment of an ACS Office of Pre-High School Education to obtain and disseminate information about useful curricular materials.

b. The ACS should advocate an increase in science requirements for the certification of pre-high school teachers.

c. The ACS should encourage granting agencies to establish programs to produce science specialists. Such specialists could provide expert science education until the general level of science training for pre-high school teachers has been improved.

II. High School Education

All students should take science courses to be prepared for a wide choice of career options as well as to appreciate the natural and technological events that surround them. The laboratory is an essential component of high school chemistry courses and should comprise at least 25% of the time allotted for chemistry instruction.

a. The ACS, through SOCED and the Division of Chemical Education, should establish curricular guidelines for high school chemistry courses.

b. The ACS should promote efforts to increase the amount of science instruction required for high school graduation.

c. To enhance the teaching profession, we recommend that the ACS encourage state education departments to establish 11 month contracts for science teachers and encourage industry to provide salary supplements for outstanding teachers, opportunities for summer employment, and sabbatical employment for chemistry teachers.

To address the long-term improvement of current deficiencies in K-12 science education, we recommend that the ACS promote the establishment of 10 regional Science Education Centers that would; 1) organize workshops for the continuing education of teachers, 2) develop curricular and instructional materials for grades K-12 and 3) assist pre-high school science specialists with material resources and personal consultation.

III. Two-Year Colleges

Courses for specific technical courses should be distinct in content and approach from transfer courses. Adequate resources and a commitment of the institution to the appropriate level of instruction are essential, but are now lacking in many cases.

a. The ACS should develop guidelines for courses at two-year colleges to improve the quality of instruction and to assist instructors in obtaining adequate resources.

b. The ACS should certify programs which produce chemical technicians, i.e., chemical technology programs.

IV. Colleges and Universities

Too little attention is now paid to the needs and desires of students in other majors who take chemistry courses (typically greater than 90% of enrollment in chemistry). The foundation courses in general and organic chemistry do not meaningfully relate chemistry to other areas of science and technology.

a. We recommend that SOCED promote dialogue between chemistry instructors and the departments they serve to develop courses better suited to other sciences and engineering.

b. We support the objectives of the Institute for Chemical Education at the University of Wisconsin -- to develop and disseminate improved curricular and instructional materials for college chemistry courses.

PANEL C: CHEMICAL EDUCATION FOR A CAREER IN CHEMISTRY

I. Career Opportunities

a. The number of students earning the BS or BA degree in chemistry is stable around 11,000 per year. About 33% continue studies in chemistry, only 27% go directly into the chemical industry. Sixteen-hundred Ph.D.'s are earned annually, about 500 continue in post-doctoral positions. There is a need for a "flywheel" to dampen the oscillations in demand for Ph.D. chemists in response to economic conditions. We propose a program of 200 two-year post-doctoral appointments in federal laboratories in addition to those currently funded through individual research grants.

b. Currently, 30% of BS degrees and 15% of Ph.D.'s are awarded to women and these fractions are expected to increase. Many women feel substantial constraints on their career opportunities. We propose an ACS-sponsored conference on problems encountered by women in chemistry, and following the conference, establishment by ACS of an action group to pursue recommendations of that conference for removing these constraints.

II. Pre-College Education

The three principal problems are: time devoted to science education, the quality of the curriculum and the preparation of teachers. Instruction in chemistry should be incorporated in science teaching at all grade levels, not just in specific courses. Two new curricula are required for elementary science: one to prepare the teachers, a second for them to teach. A high-school curriculum of broader appear is needed. We propose:

a. The ACS establish an Office for Pre-High School Education.

b. The ACS appoint a Task Force that will enable chemists to influence programs for curricula development and teacher training called for by the commissions on excellence in education.

c. SOCED and DIVCHED produce a 5-year plan outlining goals and specific proposals for achieving them for teacher development, working conditions, course content.

III. Faculty and Curricula in Colleges

a. Many of the educational programs sponsored by NSF during the 1960's were considered to be of great value, e.g. the summer institutes, summer research for undergraduates, etc. We strongly support restoration of programs of this sort.

b. The chemical profession has changed in the last decades, but there has been no systematic study of expectations employers have of individuals entering it at various levels and curricula and facilities needed to prepare them. We propose a committee to consider how best to characterize career opportunities at the associate, bachelor, master and doctorate level, and the preparation needed for them. This committee should consider the role of CPT and its capability of handling this broader assignment.

c. Recent changes require re-examination of many specific items of the curriculum, e.g., incorporation of study of historical perspective and humanistic values, the role of physical chemistry, inclusion of biochemistry and molecular biology, probability and statistics, computers and computation, chemical economics, and safety.

d. Many crities call for inclusion of more practical chemistry, e.g. that more closely related to industrial philosophy and needs. There is widespread concern that academicians down-grade industrial chemistry as a career and as a subject of interest. We propose that ACS establish an office on Academic-Industrial Cooperation to motivate and sponsor all forms of increased cooperation. As one form of that cooperation, we propose a committee on industrial innovations as teaching tools. This committee should seek out uniquely successful and chemically interesting industrial achievements, publish complete descriptive material on each for use in classroom instruction.

IV. Continuous Learning

a. Learning must be continuous, especially based on the written word. However, recent developments in electro-optical technology pose new opportunities for delivery systems to assist individuals' learning. We support the assignment of substantial resources by all agencies concerned with education to the development, testing and evaluation of both technology and subject matter.

b. The transmission, storage and retrieval of information poses increasingly difficult problems but new technology makes possible new approaches to these problems. We propose an ACS Committee on Information Management to provide leadership in application of these techniques and in recommending training and facilities appropriate for all aspects of these problems.

Appendix III

THE NEEDS AND REQUIREMENTS FOR BETTER EDUCATION IN SCIENCE AND TECHNOLOGY

I. A return to the High Standards of Excellence of the past.

(a) Standardized Final Exams
(b) Promotion and Graduation
(c) Core course requirement to develop balanced individual.

II. Teacher Evaluation

(a) Schedule Evaluations at Random Times
(b) Teacher should not be forewarned.
(c) Evaluation should be based on output - Quality of Students
(d) Evaluation should be based on productivity i.e. number of quality students produced.
(e) No Tenure
(f) Standards of Performance

III. Teacher Training

(a) More emphasis should be placed on knowledge of course content.
(b) While methods of teaching should be part of training emphasis should be placed on course knowledge.

IV. Education of Public

(a) Concerted effort must be made to re-educate and re-vitalize public on parents role in education process.
(b) Babysitters versus teaching.
(c) Courses vs. Extracurricular.

V. Recognition of Individual Needs

(a) Catagorization of students according to ability.
(b) Teaching of fundamental understanding as a basis for future education.
(c) Theoretical concepts taught only to those capable of assimilating subject but only after base fundamentals are taught.
(d) Use of athletic program and other extracurricular events to compliment education process. Avoidance of tail wagging the dog.

VI. Support of School Boards

(a) For implementing of better program
(b) For improving education process
(c) Must involve education of public
(d) Recognition that Board is there for Guiding Program to educate.

VII. Financial Resources

(a) Recognition that more isn't needed.
(b) Reduction in Administrative Costs.
(c) Decrease in staff size
(d) Limitation on multiplicity of courses. Emphasis on Core Essentials.

Appendix IV

1983 S.U. Freshman Chem. Major Survey

In September 1983 ten Freshman chemical majors at Shippensburg University were surveyed as to their career choices and the factors contributing to these choices. All had decided to pursue the B.A. degree rather than the B.S. Ed. The contributing factors are summarized below. The first column is the number of students who listed the item as an important factor. The second column refers to the number of students who listed the item as the major factor. The third column represents an attempt to assess the overall importance of a factor where 3 points were assigned to the primary factor, 2 for secondary and 1 for tertiary. The last column lists the factors volunteered by the students.

# students listing factor	# listed as major factor	overall importance	factor
8	6	14	work duties: research laboratory vs. instruction
8	1	11	financial support: salaries, equipment, etc.
6	2	7	prestige, respect, discipline
9	1	6	job opportunities and chances for advancement
1	1	3	education courses

Appendix V

1983 SEPACS/SU Conferences in Science Education Survey

1. Repondents
   a. Science teachers - 8
   b. Administrators - 1
   c. Science coordinators - 2

2.

Problem	Rank*	Per cent of Respondents who consider the problem to be: Serious	Minor	Not a Problem
a. Low prestige and lack of respect for teaching profession	26	80	20	0
b. Low teacher salaries	25	73	9	18
c. Lack of professional development activities	24	55	45	0
d. Lack of advancement opportunities in teaching track	24	70	30	0
e. Lab sizes too large	23	64	18	18
f. Class sizes too large	20	45	45	10
g. Lack of administrator support for professional development activities	20	45	45	10
h. Community exhibits a lack of understanding of problems	20	45	45	10
i. Insufficient funds for purchasing equipment and supplies	19	36	64	0
j. Lack of planning time	19	45	36	19
k.Lack of financial support for professional development activities	19	45	36	19
l. Administrators exhibit a lack of understanding of problems	19	36	64	0
m. Inadequate facilities	18	45	27	27
n. Too many assignments unrelated to teaching of subject matter	18	36	55	9

o. Inadequate student math abilities	18	36	55	9
p. Not enough time to teach subject	17	36	45	18
q. Lack of support from administrators	17	36	45	18
r. Lack of support from community	17	40	50	10
s. Lack of student interest in subject matter	16	27	64	9
t. Inadequate student reading abilities	16	27	64	9
u. Low student standards	13	18	64	18
v. Weak high school curriculum requirements	12	18	55	27
w. Lack of teacher participation in curriculum matters	11	10	80	10
x. Repetition and boredom in the classroom	10	10	70	20
y. Low administrator standards	10	9	64	27
z. Teachers inadequately prepared in subject matter	9	18	27	55
aa. Lack of teacher interest in professional development activities	9	9	55	36
bb. Out of date teaching materials	7	9	36	55
cc. Lack of teacher interest in subject matter	6	0	55	45
dd. Difficulties in maintaining discipline	6	0	55	45
ee. Low teacher standards	6	0	55	45

Rank determined by assigning 3 points to serious problems, 1 point to minor problems and 0 points to not a problem.

3. What are the three most critical problems?

Problem	# of Responses
i. Insufficient funds for purchasing equipment and supplies	6

b. Low teacher salaries	3
n. Too many assignments unrelated to teaching of subject matter	3
s. Lack of student interest in subject matter	3
a. Low prestige and lack of respect for teaching profession	2
e. Lab sizes too large	2
f. Class sizes too large	2
j. Lack of planning time	2
k. Lack of financial support for professional development activities	2
m. Inadequate facilities	1
c. Lack of professional development activities	1
d. Lack of advancement opportunities in the teaching profession	1
r. Lack of support from the community	1
z. Teachers inadequately prepared in subject matter	1
bb. Out of date teaching material	1

4. What is the most critical problem?

Problem	# of Responses
b. Low teacher salaries	3
a. Low prestige and lack of respect for teaching profession	2
m. Inadequate facilities	2
-. Lack of laboratory prep time	1
k. Lack of financial support for professional development activities	1
i. Insufficient funds for purchasing equipment and supplies	1

f. Class sizes too large	1
e. Lab sizes too large	1
s. Lack of student interest in subject matter	1